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Civil Engineering.

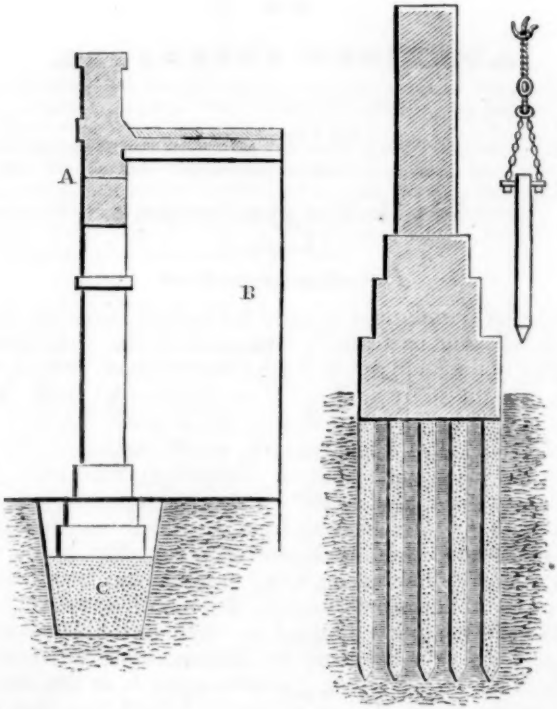
Foundations on Sand.

The subject of foundations on sand has latterly attracted a good deal of attention here, and particularly on account of Mr. Perring's discovery, that many of the buildings in Egypt were built on such foundations. "It seems that the stony surface of the desert had been made level by a layer of fine sand, and confined by a stone platform 14 feet 6 inches wide, and 2 feet 9 inches thick, which supported the external casing, and the pyramid (that of Dashhour) was built upon the sand, which is firm and solid." Other examples of the same kind were met with by Mr. Perring, and it seemed that the sand, when retained in its place, could be depended upon. We have, therefore, thought it would be interesting, while public attention is directed to the subject, to notice what has been done on this system in France. It seems to have been first adopted in 1822, by M. Devilliers, C. E., when employed on the canal of St. Martin, were he used it extensively. It is to be observed, however, that it is the only system employed in the Dutch Colony of Surinam, and was suggested long since by Captain Rosmy, but not applied.

We have no account of M. Devilliers' works, and the process seems to have remained in abeyance until 1830, when Captain Gauzence, of the French Engineers, employed it for the support of the portico of the Guard House of Mousserolles, at Bayonne. This plan is represented in fig. 1, where A, represents the front of the portico; B, the façade of the guard house; and C, the sand foundation.

The soil was a slippery, greasy clay, extending to a considerable depth, and it was at first proposed to lay down a platform of wood, as a basis. Capt. Gauzence's suggestion, however, having been adopted, the soil was dug out to about a yard below the substructure, and filled in with sand well rammed. On this were laid two courses of Ashlar masonry, and then a course of dressed stone, forming the surbase. Before finishing the columns, one of them was laden with ten tons of lead without any sensible effect being produced. The structure was finished in October, 1830, and no settlement has taken place since, though each column is computed to carry a weight of ten tons, and a wall of the same guard house, otherwise built, has settled a good deal.

Fig. 1. Fig. 2. Fig. 3.



The same plan has been successfully pursued in some of the fortifications of Bayonne, where buildings had to be placed on made ground.

In 1836, a sand foundation, about 2½ feet thick, was employed with an equally satisfactory result, for the quay wall of a small harbor on the coast of Brittany.

For the construction of the artillery arsenal at Bayonne, another

plan has been adopted. The soil is of the same greasy kind before described, while it is quite impossible to use wooden piles, for not only is wood very dear in the neighborhood, but at high water a stratum of water penetrates the soil, which rapidly rots wooden piles, or platforms. Colonel Durbach, therefore, proposed to employ what have been termed piles of sand. The forge department is surrounded by square piers united by a wall, and in fig. 2, we have a section of one of the piers, the weight of which, and of the carpentry supported, is about 35 tons.

The foundation piles are so arranged that each bears only 2 tons. The process adopted was to drive into the ground an ordinary wooden pile about 7 inches square, and 6½ feet long. This was then drawn out, and the hole filled with sand. The surface was then levelled, the sand well rammed in, and the masonry raised upon it. To draw the wooden mould pile, an ordinary machine was used, to which a chain was attached in the manner shown in fig. 3.

In 1833, Colonel Durbach's plan, with some modification, was employed by M. Mery, C. E., in the canal of St. Martin, at Paris, for the construction of a lateral culvert, which passed through ground of bad quality, in which a quantity of water was infiltrated. Instead of sand, which would have been washed away, sand mortar was used, made by mixing one seventh of hydraulic lime with six sevenths of sand, which soon consolidated.

With regard to the sand to be employed, it is recommended that it should be moderately fine, of equal grain, and not earthy. It must be moulded and rammed in layers of about 8 or 9 inches thick, which is an important point.

The theory of this process is not known, but it is supposed that the pressure is equally distributed on the sides as well as on the base. Some curious circumstances as to the pressure of sand are to be observed in connexion with blasting, where it is found to produce the most efficient tamping.

Civ. Eng. & Arch. Journ.

Great Western Steam-Ship Company.

A general meeting of the proprietors of the Great Western Steam-Ship Company was held on Thursday, March 14, at Bristol. The following is an abstract of the Directors' Report:—

"The receipts by the Great Western, for 1843, have amounted to £33,406 0*s.* 4*d.*, and the expenditure has been only £25,573 4*s.* 3*d.*; the receipts for 1842, having been only £30,830 8*s.* 2*d.*, while the expenditure was £28,615 7*s.* 1*d.* To the improved state of things in the United States much of this is to be attributed, a good deal to the close attention to expenditure; but your directors believe still more to the circumstance of Liverpool having been altogether the rendezvous for your business on this side of the Atlantic."

The report then states that the Great Western's last winter voyage to New York, by way of Madeira, had been rendered unprofitable,

the carelessness of the New York pilot having allowed her to touch the ground, in consequence of which that vessel had to be surveyed and repaired at her majesty's dockyard, at Pater, at an outlay of £606, in addition to which it was calculated that a loss of £1500, in passengers, had been sustained by the unavoidable delay, and change in the times of sailing. She had been subsequently docked in Bristol, and "thoroughly examined," when, according to the directors, it was "impossible to over rate her condition." The pilot at New York has been suspended on the representation of the company, and the underwriters at Lloyd's had signally marked their sense of Captain Hosken's merit in bringing home the vessel. "The Great Western has run nearly 240,000 miles, at a higher average speed than had been attained by any other sea-going steamer—10⅛ miles per hour." In September last, the company's engineer reported that the boilers, which had done duty for six years, might, at an outlay of £1000, be made to last for one, or, at most, two seasons longer. Under these circumstances the directors thought it better to have new boilers, the estimate for which is £3000, which are now being rapidly put up on board, are known by the name of tubular, and require only half the space of the old ones, by which the stowage of the ship, for either coals, or cargo, has been increased to the extent of upwards of 200 tons. She is also to have new paddle-wheels, which are nearly finished, and in progress of fitting in place. The directors observe:—

"Mr. Ashton, the well known ship-broker and auctioneer, was employed to effect a sale of your works, either by private contract, or by auction, and your directors regret to announce ineffectually. The time is now fast approaching when they will be closed, unless parties come forward to take them off your hands. Situated as your premises are, with water-side frontage, ample space for building, a graving dock of the first class, and in other respects a more convenient engineering and ship building establishment than any in the kingdom, your directors long since expected that they should be able to communicate to you that the mechanics and other able hands, who, before their establishment, were, many of them, strangers to Bristol, would not have had occasion to turn their backs upon the city; they still trust these hopes may be realized, and that the time will not arrive when it will be advisable to sell the tools and the materials piece-meal. Your directors have, on more than one occasion, suggested to you the good effects to be anticipated from your arming them with authority to tender for government vessels, or otherwise to work for the public. The opportunities have been numerous, and if they had been authorized to have accepted some of them, Bristol, they think, would by this time have become a steam-ship building port of the first class, and your establishment, in all probability, in a flourishing condition, instead of being, as it has a prospect of being, on your hands, subject to an outlay for rent, taxes, and maintenance, of not less than £400 per annum."

Prince Albert's visit, and the undocking of the Great Britain, are then briefly alluded to, it being stated that "the whole of the expenses of that auspicious occasion were defrayed from the fund arising from

the sale of tickets, or from visitors to the works." The report then goes on to state that, "for the purpose of opening the bank fronting the dock in the most inexpensive way," the Great Western Steam-Ship Company had obtained the permission of the Dock Company to lower the water in the float six feet. Circumstances, however, had rendered it necessary to lower the water considerably below the six feet asked for;" and on the 13th of December, nearly six months after the event, the Dock Company made a claim of £ 312 17*s.* 10*d.* for damage done to the ship Augusta, in consequence of the lowering of the water. The payment of this sum had been resisted, and the "not acceding to this demand, the directors have reason to fear, has operated injuriously upon the consent of the dock board to the passage of the Great Britain through the locks." The report then goes on to speak of the Great Britain.

"The size of your ship Great Britain, was not finally settled until the year 1839. At your annual meeting, in 1840, her dimensions were made known to you, and a model was laid before you. Before, however, the final settlement of her power and capacity, deputations from the public bodies had been, for months, sitting in committee, with the view of arriving at some conclusive recommendation to the city, by and through which it was anticipated that the trade of the port would be relieved by arrangements with the Dock Company, and its locks thrown open for the ingress and egress of a larger class of steam vessels than those which are of necessity, your directors believe, confined to Bristol only; and one of the resolutions which were reported to your town council on that occasion, as the result of the indefatigable exertions of the gentlemen composing that committee was, 'that it is essential to the trade of the port that the entrance to the floating harbor should be made wider'—at the same time your consulting engineer, Mr. Brunel, was employed by the council to survey the harbor and rivers, and did, after completing the same, hand in estimates for widening the old locks, or forming a new one.

The Great Britain's beam and form were a good deal affected by the width of the locks, which were supposed to be 45 feet nearly all the way up and down; on measuring, however, your engineers have since found they are much narrower, even at the average high water mark. The great buoyancy of iron ships is such, that to gain a draft of water, which then, as well as in the present state of knowledge of ship building, was supposed to be necessary to give stability, and the other qualities necessary for a sea-going steamer, the usual form of steam-ship building had to be abandoned, and the breadth towards the bottom considerably contracted; capacity, consequently, had to be looked for above rather than below the water line. This and other considerable advantages led to the adoption of the form in which the Great Britain is built, her widest part being far above the line of flotation; and they have great pleasure in stating that she has been visited by most of the eminent ship builders and engineers of this and the neighboring kingdoms, and her construction and form not merely highly approved of, but greatly admired. About the middle of the year 1841, your engineers reported to your directors, that a great

saving would follow putting the boilers on board in dock, and, at the same time, they were informed that it was not likely the ship would be allowed to occupy nearly a whole side of Cumberland basin for so long a time, as it was then discovered would be necessary to complete her equipment; and in 1842, your directors reported to you that the most economical way of getting the machinery on board would be through an aperture in her side while in the dock, by which the necessity of floating her would be avoided. Your directors were fully aware that by this decision they would have to seek the consent of the dock directors for a temporary removal of two or three of the upper courses of stones of the lock, and the unshipping of the gates of either one, or both, sides for a few days, which they were assured by your consulting engineer, who acted in the same capacity for the dock directors, would be a matter comparatively inexpensive in execution, without risk, easy of accomplishment, and in no way likely to inconvenience the trade of the port."

The report then proceeds to detail the unsuccessful negotiations with the Dock Company, respecting the facilities afforded for getting the Great Britain into and out of Cumberland basin; the directors observing, that they had not anticipated such a termination to the negotiations, more especially as "the actual dues on the Great Western, received by the Dock Company, have amounted to £2,500, while those upon her several cargoes, which the directors have no means of computing, must have been considerable." The consequence of this want of agreement between the two companies, is that instead of getting the Great Britain into Cumberland basin on the 21st inst., and out of it for Kingroad on the 4th of April, it is "the painful duty" of the directors to inform the Steam-Ship Company, that they anticipate so much delay from the plan which they are now driven to adopt, that they think it will be impossible to keep the advertised dates of the sailings of the Great Britain. The report then goes on to state:—

"The expenses for experiments on the *Archimedes* have been reported to you. Your directors regret that she was taken away before they were completed. A three-armed screw made for her at your works, was tried by Mr. Guppy, on the French man-of-war Napoleon, a vessel of more than double the power of the Archimedes, and with it a high speed was attained; and your directors believe with a screw of proper size on a similar plan, she is, at this moment, admitted to be the fastest man-of-war afloat. Your consulting engineer's services have been engaged by the Lords of the Admiralty to report upon screws, and for this purpose her majesty's ship Rattler, of 800 tons, and 200 horse-power, has been placed at his disposal. Her experiments have been frequently attended by one, or other, of your officials, as were also experiments, three years ago, upon her majesty's ship Polyphemus, a sister vessel, with paddle-wheels. In her a speed of nine knots was attained in Southampton water. The late results of the Rattler have been nine and a half, better than half a knot over the speed of the Polythemus, as well as of another sister vessel of the same power, and in the same place with paddle-wheels—her majesty's

ship Prometheus in the Thames. Your directors have been induced to dwell upon this subject, not merely in consequence of its importance, but because of garbled statements of speeches in the House upon the navy estimates, or of assertions not founded on the real facts of the case, having led many of the proprietors to seek for information at your office. Your consulting engineer, and Mr. Smith, the patentee, are acting with the most perfect understanding, and the speed of the Rattler has been improved with every alteration of the screw, the principle, your directors believe, remaining the same. Your directors greatly regret that it became necessary to put the Great Britain's screw in hand before the experiments in the Rattler were concluded. They will not quit this subject without reminding you that it has never been asserted that a higher rate of speed is expected to be attained in perfectly smooth water, with a screw than with paddles; but that it has numerous advantages over the paddle for long voyages on the ocean, and that the averages are likely to be better; and as certain authorities have asked what the speed of the Rattler is, or what about 11 statute miles per hour is to 15 or 16, or even more, which is reported to have been attained by fast boats on the Thames, the Hudson, and other rivers; you are to recollect that the power in her majesty's ships is seldom more than one horse to four tons, while in the fast river boats it is about as one to two tons, or even less, and that few, if any of them, would be safe at sea in bad weather, from the slightness of build, and disproportion of weights. The Elberfelt, recently caught crossing the channel, is a case in point. If your directors are rightly informed, she was built for the Elbe, of iron one-eighth of an inch thick, and did not draw two feet of water. The accounts of the company are appended to the report, and after reserving the sum of £430 13*s.* for the reduction of the preliminary expenses of the company, and £767 in reduction of stock, a dividend has been declared of £2 10*s.* per share, or 7½ per cent. on the original cost, or 9¾ per cent. on the reduced cost of the Great Western, which will become payable on the 15th inst., free of income tax, leaving a balance of £1,511 9*s.* 1*d.* to be carried to the reserved fund, making the amount, with interest, £13,139 3*s.* 4*d.* in reduction of the original cost of the Great Western.

Subjoined to the report is a statement of accounts, in which the following is given as the cost of the Great Britain.

Hull, engines, and boilers,	£66,790	3	10
Fittings,	8,908	13	8
Masts, rigging, boats, pumps, cables, and stores,	2,110	9	4
General expenditure, including screw experiments,	19,344	17	6
	£97,154	4	4

Ibid.

The Screw and Paddle-Wheel Trial.

A government trial of the screw propeller took place on the 3rd of March, with her majesty's steamer Rattler, at the measured distance in Long Reach, in order to determine, as correctly as possible, her rate of going, as compared with that of her sister ship Prometheus, which had been ascertained by the government authorities the day before, by a similar trial. The Rattler having been built for the purpose of testing the merits of the screw propeller with those of the paddle-wheels, is constructed, as nearly as possible, upon the lines and models as the Prometheus; they have both the same amount of engine power, viz., 200 horses; both vessels were laden to the same draught of water, viz., 11 feet 3 inches; the steam pressure in both cases was regulated alike, in fact, every thing that could be conveniently done to render the trial a fair one was duly attended to. Under these circumstances more than ordinary interest was excited amongst the naval and engineering officers connected with the Woolwich Dockyard establishment, by whom the results of the various trials of both vessels were most minutely noted, and, in the end, summed up, contrary to the general expectation, in favor of the Rattler, to the extent of nearly half a knot per hour, their relative speed being as follows:—Prometheus, 8.757 knots; Rattler, 9.240 knots, or within a fraction of 10¼ statute miles per hour. The Prometheus is one of the third class war steamers recently introduced into her majesty's navy by the present surveyor, Sir William Symonds, and is, we are informed, under orders to sail almost immediately for the Mediterranean.

Having given the particulars of the government trial of the screw propeller, and the paddle-wheel, with her majesty's steam-ships the Rattler and Prometheus, the former vessel was fitted with the screw, and the latter the paddle-wheel; as the experiment is one of importance, we have taken the trouble to obtain the proportions of the Rattler. We understand that as far as the build of the vessel, the porportions of the Prometheus are nearly the same.

Dimensions of H. M. S. Rattler.	Feet.	Inches.
Length, extreme,	195	0
Ditto, on decks,	176	6
Ditto, on keel for tonnage,	157	9½
Breadth, extreme,	32	8½
Ditto, moulded,	31	10
Depth of hold,	18	7½
Burthen in tons 888$\frac{3}{94}$,		
Draught of water, (mean)	11	3
Area of midship section at 11 ft. 3 ins.	280	
Engines—Maudslay's 4 cylinders, aggregate power 200 horses:—		
Diameter of cylinders,	00	40

Dimensions of H. M. S. Rattler.	Feet.	Inches.
Length of stroke,	4	0
Diameter of screw,	9	0
Pitch of ditto,	11	0
Length originally,	5	6
Ditto as reduced on the occasion of the trial,	3	0

Number of treads two.

The gearing at present consists of two motions, which gives a velocity of four to one of the engine. The first motion of two to one consists of a large spur wheel and pinion, the cogs of which are divided into three parts, thus—

those of the larger wheel being made of hard wood, and the smaller one of iron; this sub-division of the wheels prevents that very disagreeable rattling which is so much complained of.

The second motion consists of a large and small drum, with their surfaces divided into seven convex parts, thus—

upon which seven leather straps, of five inches in width, are kept tight by a suitable pulley, or drum, for that purpose. The drum and straps have merely been put in to try their efficiency, and to allow the multiple to be diminished, or increased, as circumstances may require. It is intended, when the experiments have been completed, to remove the drums and straps, which will be replaced by a single wheel and pinion of requisite proportions.

It is estimated that from 18 to 20 horse-power is absorbed in transmitting the power of the engine through the medium of straps at so great a velocity as is required to drive the screw.

Diameter of Gearing.	Feet.	Inches.
Diameter of spur wheel,	11	2
Width,	2	6
Pitch,	0	5
Diameter of pinion,	4	4
Ditto, large drum,	10	6
Ditto, of small drum,	6	9

The boilers are upon the ordinary flue principle.

The boilers of the Prometheus are upon the new tubular principle, the diameter of her two cylinders 52½ inches, length of stroke 4 feet 6 inches. Ibid.

Ball and Socket Leveling Instrument.

A ball and socket leveling instrument, constructed by Mr. Adie,

for Thomas Stevenson, Esq., C. E., and also an improved portable leveling instrument and rod, were exhibited. Communicated by David Stevenson, Esq., F.R.S.S.A., C. E. In this ball and socket spirit level, designed by Mr. Thomas Stevenson, C. E., the first peculiarity is the substitution of a small circular level fixed upon the upper side of the tube, for facilitating the setting of the instrument, instead of the delicate cross level at present in use. But the principal advantage of Mr. T. Stevenson's improvement consists in the combination of the ball and socket motion for the first setting, previous to the application of the parallel plate screws for the final adjustment. The ball and socket was long in use, but for about half a century it has been almost entirely discarded, and the parallel plate screws substituted. In the level exhibited to the Society, the ball and socket has been restored, and the parallel plate screws retained, so that by this union the advantages peculiar to both systems have been attained. The person using this instrument is, in consequence, rendered quite independent of the rugged nature of the ground on which it is set, or the inclination of the telescope to the horizon, as by looking first at the small circular level, he can in an instant bring it nearly right by means of the ball and socket, after which a slight touch of the parallel plate screws perfects the adjustment. In this way the observer can set his instrument with exactly the same rapidity and ease on a steep slope as on level ground, and is enabled to proceed with equal facility at such rugged stations as would, in the instrument now in common use, altogether exceed the range of the parallel plate screws. The practical surveyor will see the great saving of time and trouble resulting from the use of Mr. Stevenson's instrument.

Mr. David Stevenson also showed a portable level and rod, constructed to his directions, by Mr. Adie. With nearly the same accuracy as the large levels, this instrument possesses the advantage of much greater portability. It combines a telescope 10 inches long, a compass, and a level, and is packed in a flat leathern case measuring about 6 inches by 2¾ inches, rendering it very convenient for perambulatory surveying, for which it was made. It rests on a tripod, which is also very portable. The leveling rod accompanying this instrument, when closed, forms a round staff 3 feet 6 inches long, which is cut longitudinally through the centre. The two parts are hinged at one extremity, and when the rod is to be used they are opened and fixed by a spring. The scale is marked on the flat side, and when the staff is closed the figures are protected from injury.—*Trans. Roy. Scot. Soc. Arts.* Ibid.

Wrought Iron Lattice Bridge erected across the line of the Dublin and Drogheda Railway.

At the meeting of the Institution of Civil Engineers of the 9th ult., Mr. G. Hemans read a description of this bridge. In construction, it is similar to the wooden lattice bridges of America, only substituting wrought-iron for timber, and is situated about three miles from Dub-

lin, over an excavation of 36 feet in depth; its span is 84 feet in the clear, and the two lattice beams are set parallel to each other, resting at either end on plain stone abutments built in the slope. These beams are 10 feet in depth, and are formed by a series of flat iron bars 2½ inches wide by ⅜ of an inch thick, crossing one another at an angle of 45°; at 5 feet 6 inches above the bottom edge transverse bearers of angle iron are fixed, similar to those now used for supporting the decks of iron steam vessels, and upon these the planking for the roadway is fastened. The account of the mode of construction, and of the raising and fixing the lattice beams, by Messrs. Perry, of Dublin, the contractors, was given in detail; and the author stated that although it was expected that considerable deflection would occur, which was provided for by forming the beams with a curve of 12 inches in the centre, they did not sink at all, even when heavy weights passed over them. The total cost of the structure, including the masonry of the abutments, was £ 510.

Glasgow Mech. & Eng. Mag.

The Menai Bridge.

The following particulars relative to the Menai bridge, may prove acceptable to many of our readers. The distance between the piers is 551 ft. The elevation of the roadway above high water mark 102 ft. The width of the roadway is 28 ft., viz., the two carriage-ways 12 feet each, and the footway 4 ft. The weight of the chains between the piers, including pins, plates, &c., is 398 tons. The weight of the vertical rods, flanking, &c., previous to the repairs rendered necessary by the hurricane on the 7th of January, 1838, was 246 tons, making a total weight of 644 tons, which is equal to a strain at each point of suspension of 1.100 tons. The additional flanking, &c., used in repairing the damage done by the hurricane of the 7th of January, 1838, was about 140 tons, thus making the present weight between the piers 784 tons. The sectional area of the 16 chains is 260 square inches, which, at 27 tons per square inch, will bear 7,020 tons without breaking. To insure permanence, however, the bridge should never be loaded above a quarter rate. This would produce a tension of 9 tons to the square inch, which iron will bear without stretching. At this rate the bridge would bear constantly without injury 2,340 tons, leaving a surplus power over its own tension of nearly 1,240, which is equivalent to 733 of direct weight. The area of the platform, or roadways, between the piers is 15,240 square feet. The bridge would hold, allowing 2 feet per man, 7,620 individuals. Taking them upon an average of 150 pounds, they would weigh 466 tons, being nearly 300 tons less than the bridge could constantly bear without injury.

Ibid.

Extracts from the Proceedings of the Institution of Civil Engineers.—From the London Athenæum.

Screw Propellers—Feb. 27.—The discussion on the subject of screw propellers was continued.* The main dimensions of the Princeton, United States steam frigate, were given: she is 164 feet long, 30 feet beam, 22 feet 6 inches deep in the hold, draws 17 feet 6 inches of water, and the propeller makes 32 revolutions per minute. The engines have two semi-cylindrical steam cylinders, or chests, containing vibrating pistons, or flaps, with cranks upon the ends of their suspending pivots: both these are coupled by connecting rods to a main crank on the driving shaft; the length of these cranks are so proportioned that their alternate vibrations produce a rotary motion of the main crank, and thus act directly upon the propeller without the intervention of bands, or gearing. This principle was some years since tried successfully by Captain Ericsson, in a tug boat on the Thames, named the Robert F. Stockton, after the projector, who has been the means of introducing the system into the American navy, and now commands the Princeton. It was mentioned, that recently, on being examined at Marseilles, the cast-iron propeller of the Napoleon, French steamer, was found to be much affected by the galvanic action of the copper sheathing in the salt water, and was fast turning into a substance resembling plumbago, which was so soft as to be cut easily with a knife. Some remarks were also made on the state of the metal guns recovered from the Royal George; but it appeared from examination of the effect of salt water alone upon cast-iron, without the contact of other metals to produce galvanic action, that good, hard, grey, cast-iron might be used for piles, or other hydraulic works, with great advantage, and instances were given of cast-iron which exhibited no appearance of change after sixteen years' immersion in salt water and silt.

Bridge of Cast-Iron Girders.—A paper was read giving a description, by Mr. Rhodes, of a bridge built of cast-iron girders upon timber piles, having a swivel bridge at one extremity, with an opening of 40 feet span, through which the navigation of the river was carried on. The total length of the bridge, exclusive of the width of Hayes' Island, was stated to be 558 feet 6 inches; it stretches across the river Shannon at Portumna, by 13 openings of 20 feet each, from the Tipperary shore to Hayes' Island, which is in the centre of the river, and thence by 12 openings, of a similar span, and a swivel bridge of 40 feet span, to the Galway shore. The construction, which was executed from the designs of Mr. Rhodes, was described and illustrated by drawings, showing every detail of the works, which were stated to have cost £24,131.

Bridge over the River Whitadder—March 5.—The first paper read was a description, by Mr. J. T. Syme, of the bridge over the river Whitadder, at Allanton. This bridge, which was executed at the

* See Journal of the Franklin Institute, page 299.

expense of Miss Boswall, of Blackadder, from the designs of Messrs. Stevenson & Sons, of Edinburgh, consists of two arches of 75 feet span each, with a versed sine of 11 feet 6 inches, the centre pier being 32 feet 1 inch long, and 10 feet in breadth, making the distance between the faces of the abutments 160 feet; it was constructed of soft red sand stone, and the abutments were built up solid, the greater part of the masonry being ashlar: the total cost of the bridge was stated to be £ 6,058.

Wrought-Iron Girders, and Cast-Iron Transoms.—A paper, by Mr. F. Nash, was read, describing a new kind of girder, composed of a number of diagonal bars of wrought-iron, abutting against each other, with cast-iron transoms, these latter supporting the pressure, and the former the tension. This mode of construction has been recently introduced in France for bridges, and the paper, after describing a number of preliminary experiments on small girders, gave the details of the proofs to which four girders, placed side by side, with a bearing of 74 feet 8 inches, had been subjected, by order of M. Teste, the minister of Public Works, Paris. From this it appeared that with a load of 62 tons, the deflexion in the centre was $1\frac{3}{12}$th of an inch, and that the girders resumed their original position on the weight being removed, after bearing it for a month. In order to test the effect of a sudden shock, a cart, loaded with 4½ tons of iron, was caused to break down suddenly in the centre of the bridge, without producing any prejudicial effect beyond crushing the flooring planks. The weight of these four girders was 20¼ tons.

Wellington Bridge.—An account of the building of Wellington Bridge, over the river Aire, at Leeds, by Mr. J. Timperley, was read. This bridge was executed from the designs of the late Mr. Rennie, about twenty years since; it crosses the river where it is 100 ft. wide, and 6 ft. deep; it consists of a segmental arch of 100 feet span, with a versed sine of 15 feet, constructed of stones from the quarries of Bramley Fall, which are about four miles from the bridge; the abutments are built in radiating courses, except the external faces, which are horizontal, the whole being well bonded together; the total quantity of masonry is 80,000 cubic feet. The method of forming the foundations, as well as the coffer-dams and centre, was given in detail, and it was stated that the total cost of the bridge was only £ 7,270.

Ancient Arches.—Mr. G. Rennie made some remarks on the ancient arches, of which traces have been discovered by the recent researches of travelers, alluding to Perring's account of ancient arches discovered at Thebes, the bricks of which bore the name of Sesostris, which would carry back the knowledge of the arch to a period of upwards of three thousand years. He noticed also the use of the stone lintel among the Greeks, the Etruscan arch found in Italy, and also the more modern but very bold arches still remaining in Italy, Portugal, and Spain.

March 12.—The discussion upon the knowledge of the properties

of the arch possessed by the ancients, was renewed on the presentation, by Mr. Page, of drawings of two arches standing near some cyclopæan remains at Cape Crio (Cnidus.) There was no positive evidence of the date of these arches, but from their being built without mortar, and the massiveness of their construction, it was agreed that they were probably of the same period as the cyclopæan works among which they were situated.

Casks used in Floating large Stones.—These casks, which were strongly built of fir staves, hooped externally with iron, and supported inside by radiating bars, like the spokes of a wheel, were used, instead of crane barges, for conveying stones of thirty to forty tons weight, for securing the foot of the sea walls of Banff Harbor, which had failed. Two of these casks, of 445 feet cube each, were used to convey stones of thirty tons weight, by passing the two chain cables, which were wound round them, through the eyes of the lewises, which were fixed in the stone at low water, at which time the chains being hauled down tight, when the tide flowed, the buoyancy of the casks floated the stones, and they were towed by a boat over the place where the stone was intended to be deposited—the lashing being cut away, the stone fell into its seat. This method was found to succeed in weather that would have destroyed any crane barges; and the works of Banff Harbor were thus secured from further degradation, and were subsequently restored at a comparatively small cost. The drawings and enlarged diagrams gave the details of this method.

Railway Switch.—A model of Faram's railway switch was exhibited, and its self-acting motion, in guiding the carriages into the sidings, or on the main lines, as required, was shown by the inventor. These switches were stated to have been used on the Grand Junction Railway for some time.

Properties of the Arch—March 19.—Col. Leake made some remarks on the knowledge possessed by the Greeks of the properties of the arch; he contended that numerous example still exist of their having used it; but from the solidity of their constructions, the nature of the materials they employed, and the architectural character of the edifices, which were chiefly temples, the arch was evidently less employed than among the Romans, who used different and less solid materials.

Hydraulic Traversing Frame.—The next paper read was a description of an hydraulic traversing frame, at the Bristol terminus of the Great Western Railway, by Mr. A. J. Dodson. The action of this machine, the object of which is to transport the railway carriages from the arrival side of the terminus to the departure side, or to any one of several intermediate lines, was thus described: an opening being made in the train, the apparatus is pushed on to the line of rails, and the carriage required to be moved is run over it when the frame is quite down, it being then sufficiently low to allow the carriages to pass freely over. As soon as the carriage is brought directly over the apparatus, a man works a pump, acting upon four hydraulic

presses, which raise the frame until both sides are in contact with the axles of the carriage wheels, and raise the flanches of the wheel clear of the rails; the whole apparatus, with the carriage suspended upon it, is then easily transported to any of the lines of rails, when, by unscrewing a stopper, which allows the water to flow back from the presses into its cistern, the carriage is lowered on to the rails, and the apparatus is rolled over, ready for recommencing the operation, the whole transit not occupying more than one minute and a half. The action of the apparatus, made by Mr. Napier, was stated to be very satisfactory, and its cost to have been about £220.

American Patents.

Information to persons having business to transact at the Patent Office.

(Continued from page 312.)

Exhibition of Models and Manufactures.

Sec. 67. Models of unpatented machines, specimens of compositions, and of fabrics, and other manufactures, or works of art, will be received and arranged in the national repository of the Patent Office, as soon as the new building is finished.

Sec. 68. The personal attendance of an applicant at the Patent Office, to obtain a patent, is unnecessary. The business can be done by correspondence, (free of postage) or by attorney.

Oaths, or Affirmations.

Sec. 69. Any magistrate, having general authority to administer oaths, is qualified to take depositions in matters relating to patents.

Forms which may be used in making applications at the Patent Office:

Form of Petition.

Sec. 70. To the Commissioner of Patents:

The Petition of Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts,

Respectfully Represents:—

That your petitioner has invented a new and improved mode of preventing steam boilers from bursting, which, he verily believes, has not been known, or used, prior to the invention thereof by your petitioner. He, therefore, prays that letters patent of the United States may be granted to him therefor, vesting in him, and his legal representatives, the exclusive right to the same, upon the terms and conditions expressed in the act of Congress in that case made and provided; he having paid thirty dollars into the Treasury, and complied with other provisions of said act.

Sebastian Cabot.

Form of Specification.

SEC. 71. To all whom it may concern:

Be it known, that I, Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts, have invented a new and improved mode of preventing steam boilers from bursting, and I do hereby declare that the following is a full and exact description thereof:

The nature of my invention consists in providing the upper part of a steam boiler with an aperture, in addition to that for the safety-valve, which aperture is to be closed by a plug, or disk, of alloy, which will fuse at any given degree of heat, and permit the steam to escape, should the safety-valve fail to perform its functions.

To enable others, skilled in the art, to make and use my invention, I will proceed to describe its construction and operation: I construct my steam boiler in any of the known forms, and apply thereto gauge-cocks, a safety-valve, and the other appendages of such boilers; but, in order to obviate the danger arising from the adhesion of the safety-valve, and from other causes, I make a second opening in the top of the boiler, similar to that made for the safety-valve, as shown at A, in the accompanying drawing; and in this opening I insert a plug, or disk, of fusible alloy, securing it in its place by a metal ring and screws, or otherwise. This fusible metal, I, in general, compose of a mixture of lead, tin, and bismuth, in such proportions as will insure its melting at a given temperature, which must be that to which it is intended to limit the steam, and will, of course, vary with the pressure the boiler is intended to sustain. I surround the opening containing the fusible alloy by a tube B, intended to conduct off any steam which may be discharged therefrom. When the temperature of the steam, in such a boiler, rises to its assigned limit, the fusible alloy will melt, and allow the steam to escape freely, thereby securing it from all danger of explosion.

What I claim as my invention, and desire to secure by letters patent, is the application to steam boilers of a fusible alloy, which will melt at a given temperature, and allow the steam to escape, as herein described; using for that purpose any metallic compound which will produce the intended effect.

Witness: { John Doe. / Richard Roe. } SEBASTIAN CABOT.

SEC. 72. When the application is for a machine, the specification should commence thus:

Be it known, that I, , of , in the county of , and State of , have invented a new and useful machine for—[stating the use and title of the machine; and if the application is for an improvement, it should read thus: A new and useful improvement on a, or on the, machine, &c.]—and I do hereby declare that the following is a full, clear, and exact description of the construction and operation of the same, reference being had to the annexed drawings, making a part of this specification, in which fig. 1, is a perspective view; fig. 2, a longitudinal elevation; fig. 3, a transverse section, &c., [thus describing all the sections

of the drawings, and then referring to the parts by letters.] Then follows the description of the construction and operation of the machine, and ending with the claim, which should express the nature and character of the invention, and identify the part, or parts, claimed separately, or in combination. If the application is for an improvement, the original invention should be disclaimed, and then the claim confined to the improvement.

Form of Oath.

SEC. 73. County of Hampden, State of Massachusetts, ss:
On this day of , 183 , before the subscriber, a personally appeared, the within named Sebastian Cabot, and made solemn oath, [or affirmation,] that he verily believes himself to be the original and first inventor of the mode herein described for preventing steam boilers from bursting, and that he does not know, or believe, the same was ever before known, or used: and that he is a citizen of the United States.

(Signed) A. B.

Form of Withdrawal.

SEC. 74. To the Commissioner of Patents:

Sir,—I hereby withdraw my application for a patent for improvements in the steam boiler, now in your office, and request that twenty dollars may be returned to me, agreeably to the provision of the act of Congress authorizing such withdrawal.

SEBASTIAN CABOT.

Cabotville, Mass., March 1, 1838.

Form of Surrender of a Patent for Reissue.

SEC. 75. To the Commissioner of Patents:

The Petition of Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts,

Respectfully Represents:—

That he did obtain letters patent of the United States, for an improvement in the boilers of steam engines, which letters patent are dated on the first day of March, 1835. That he now believes that the same is inoperative and invalid, by reason of a defective specification, which defect has arisen from inadvertence and mistake. He, therefore, prays that he may be allowed to surrender, and he hereby does surrender, the same, and requests that new letters patent may issue to him for the same invention, for the residue of the period for which the original patent was granted, under the amended specification herewith presented; he having paid fifteen dollars into the Treasury of the United States, agreeably to the requirements of the act of Congress in that case made and provided.

SEBASTIAN CABOT.

Form of Assignment of a Right in a Patent.

SEC. 76. *Whereas*, I, Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts, did obtain letters patent of the United States, for certain improvements in steam engines, which

letters patent bear date the first day of March, 1835; and whereas, John Doe, of Cabotville, aforesaid, is desirous of acquiring an interest therein: *now this indenture witnesseth*, that, for, and in consideration of the sum of two thousand dollars, to me in hand paid, the receipt of which is hereby acknowledged, I have assigned, sold, and set over, and do hereby assign, sell, and set over, all the right, title, and interest, which I have in the said invention, as secured to me by said letters patent, for, to, and in, the several States of New York, New Jersey, and Pennsylvania, and in no other place, or places; the same to be held and enjoyed by the said John Doe, for his own use and behoof, and for the use and behoof of his legal representatives, to the full end of the term for which said letters patent are, or may be, granted, as fully and entirely as the same would have been held and enjoyed by me, had this assignment and sale not have been made.

In testimony whereof, I have hereunto set my hand, and affixed my seal, this first day of March, 1838.

Witness: { A. B. / C. D. } SEBASTIAN CABOT, [L. S.]

Form of Disclaimer.

SEC. 77. To the Commissioner of Patents:

The Petition of Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts,

Respectfully Represents:—

That he has, by assignment, duly recorded in the Patent Office, become the owner of a right, for the several States of Massachusetts, Connecticut, and Rhode Island, to certain improvements in the steam engine, for which letters patent of the United States were granted to John Doe, of Boston, in the State of Massachusetts, dated on the first day of Mach, 1835. That he has reason to believe that, through inadvertence and mistake, the claim made in the specification of said letters patent is too broad, including that of which the said patentee was not the first inventor. Your petitioner, therefore, hereby enters his disclaimer to that part of the claim in the afore named specification, which is in the following words, to wit: "I also claim the particular manner in which the piston of the above described engine is constructed, so as to insure the close fitting of the packing thereof to the cylinder, as set forth;" which disclaimer is to operate to the extent of the interest in said letters patent vested in your petitioner, who has paid ten dollars into the Treasury of the United States, agreeably to the requirements of the act of Congress in that case made and provided. SEBASTIAN CABOT.

When the disclaimer is made by the original patentee, it must, of course, be so worded as to express that fact.

Form of Caveat.

SEC. 78. To the Commissioner of Patents:

The Petition of Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts,

Respectfully Represents:

That he has made certain improvements in the mode of construct-

ing the boilers of steam engines; and that he is now engaged in making experiments for the purpose of perfecting the same, preparatory to his applying for letters patent therefor. He, therefore, prays that the subjoined description of his invention may be filed as a *Caveat*, in the confidential archives of the Patent Office, agreeably to the provisions of the act of Congress, in that case made and provided; he having paid twenty dollars into the Treasury of the United States, and otherwise complied with the requirements of the said act.

SEBASTIAN CABOT.

Cabotville, March 1, 1838.

SEC. 79. Here should follow a description of the general principles of the invention, so far as has been completed.

Form for Addition of New Improvements.

SEC. 80. To the Commissioner of Patents:

The Petition of Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts,

Respectfully Represents:—

That your petitioner did obtain letters patent of the United States, for an improvement in the boilers of steam engines, which letters patent are dated on the first day of March, 1835; that he has since that date, made certain improvements on his said invention; and that he is desirous of adding the subjoined description of his said improvements to his original letters patent, agreeably to the provisions of the act of Congress, in that case made and provided; he having paid fifteen dollars into the Treasury of the United States, and otherwise complied with the requirements of the said act.

SEBASTIAN CABOT.

SEC. 81. *Form of Assignment before obtaining Letters Patent, and to be Recorded preparatory thereto.*

Whereas, I, Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts, have invented certain new and useful improvements in the boilers of steam engines, for which I am about to make application for letters patent of the United States; and whereas, John Doe, of Cabotville, aforesaid, has agreed to purchase from me all the right, title, and interest which I have, or may have, in, and to, the said invention, in consequence of the grant of letters patent therefor, and has paid to me, the said Cabot, the sum of five thousand dollars, the receipt of which is hereby acknowledged. Now, this indenture witnesseth, that for, and in consideration of, the said sum to me paid, I have assigned and transferred, and do hereby assign and transfer, to the said John Doe, the full and exclusive right to all the improvements made by me, as fully set forth and described in the specification which I have prepared and executed preparatory to the obtaining of letters patent therefor. And I do hereby authorize and request the Commissioner of Patents to issue the said letters patent to the said John Doe, as the assignee of my whole right and title thereto, for the sole use and behoof of the said John Doe, and his legal representatives.

In testimony whereof, I have hereunto set my hand, and affixed my seal, this first day of March, 1838.

Witness: { A. B. / C. D. } SEBASTIAN CABOT, [L. S.]

SEC. 82. *Form of Oath on Restoring Drawings, or Sketches, from which Drawings may be made, to replace the originals destroyed in the Office.*

County of Hampden, State of Massachusetts, ss:

On this first day of March, 1838, before the subscriber, a , personally appeared, Sebastian Cabot, of Cabotville, in the State of Massachusetts, and made solemn oath that he is the inventor [or is interested in the invention, as administrator, &c.] of an improved mode of preventing the explosions of steam boilers, for which letters patent of the United States were granted to him, dated the first day of January, 1835, and that the annexed drawing, or sketch, is, as he verily believes, a true delineation of the invention described in the said letters patent.

SEC. 83. If the following questions can be answered affirmatively before transmitting the papers, few applications will be returned for correction, or omissions:—

1. Is the fee transmitted?
2. Is the petition signed, and addressed to the Commissioner of Patents?
3. Is the specification signed, and witnessed by two witnesses?
4. Are the drawings described, and referred to in the specification? If not, are they signed before two subscribing witnesses, and are they accompanied with written references?
5. Are duplicated drawings sent?
6. Has the inventor made oath to his being a citizen, and that his invention is new?
7. Does the specification contain a specific claim?
8. If an alien and resident, is this affirmed, or sworn, to?
9. Has the model been sent, and how?
10. Is the name of the inventor durably affixed to the same?
11. In case of reissue, is the old patent surrendered?
12. Has the oath of invention been renewed, before appealing from the decision of the Commissioner?
13. Have the fees been remitted in coin, or by certificate of deposit?
14. In case of reissue, disclaimer, addition of an improvement, or patent for an improvement on an existing patent to inventor, assignee, or possessor, of the original patent, have model and drawings of the original patent (if granted before the 15th of December, 1836,) been transmitted?

Information under the Act of August 29, 1842.

ART. 1. This act authorizes the Treasurer of the United States to repay any money which has been paid into the Treasury by actual

mistake, as for patent fees, thus precluding the necessity of special application to Congress for relief.

ART. 2. The privilege of renewal of lost patents is now extended to those *granted* before the fire of December, 1836. Heretofore it has been limited to those actually *lost* before the fire, thus excluding many lost subsequently, and before they were recorded anew in this office, leaving the inventor without remedy.

ART. 3. Protection is by this act extended to a *new* class of objects, viz:—

To new and original *Designs:*

— for a manufacture of metal and other materials:

— for the printing of woolen, silk, cotton, or other fabrics:

— for busts, statues, or bas relief, or composition in alto, or basso, relievo:

— for any impression, or ornament, or to be placed on any article of manufacture in marble, or other material:

— for any new and useful pattern, print, or picture, to be in any manner attached to, or fixed on, any article of manufacture:

— for any new, or original, shape, or configuration, of any article of manufacture; all such designs not being previously known, or used by others.

ART. 4. American ministers, consuls, &c., residing abroad. may administer the oath required for applicants not resident in the United States. Heretofore such functionaries were not authorized to perform this act, thus subjecting applicants, in foreign countries, to much inconvenience.

ART. 5. The stamping, or affixing, the name of any patentee on any article without authority so to do, or the affixing the word *patent*, or *letters patent*, or the stamp, mark, or device of any patentee on any unpatented article, for the purpose of deceiving the public, is forbidden under a penalty not less than one hundred dollars.

ART. 6. Patentees, or their assignees, are now required to affix the date of the patent on each article vended, or offered for sale, under a like penalty—thus affording to the public notice of the duration of the patent—when the article is of such a nature that the date cannot be printed thereon, it should be affixed to the case, or package, containing it.

It will be observed that this act does not repeal, or change, the law under which patents have heretofore been granted, but is merely additional thereto—all patents, except for *designs*, being granted for fourteen years, and the fee, as hitherto, being thirty dollars.

Before the grant of any patent under this act, the application must be made by petition to the Commissioner of Patents, signed by the inventor.

He is also required to furnish a written description, or specification, of his invention, or production, in which the same shall be fully and

clearly described—such specification to be signed, witnessed by two witnesses, and verified by his oath, or affirmation.

In all cases which admit of representation by drawings, the application must be accompanied by duplicate drawings, and a specimen—and in other cases by duplicate specimens.

The provisions of the 6th Section do not apply to patents granted prior to the passage of this act.

Forms of Application for Patents on Designs under the Act of August 29, 1842.

To the Commissioner of Patents:

The Petition of Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts,

Respectfully Represents:—

That your petitioner has invented, or produced, [a new design, or figure, to be stamped, or printed on fabrics, which, when thus printed, are termed calicoes,] which he verily believes has not been known prior to the production thereof by your petitioner. He, therefore, prays that letters patent of the United States may be granted to him therefor, vesting in him, and his legal representatives, the exclusive right to the same, upon the terms and conditions expressed in the act of Congress, in that case made and provided; he having paid fifteen dollars into the Treasury, and complied with other provisions of the said act.

SEBASTIAN CABOT.

Specification.

To all whom it may concern:—

Be it known, that I, Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts, have invented, or produced, a new design, or figure, to be printed on fabrics, which, when thus printed, are termed calicoes, and I do hereby declare that the following is a full and exact description of the same. [Here follows a description of the design, or figure, with reference to the specimen, or to a drawing of it, in all cases which admit of representation by drawings.]

The specification to conclude with declaring what the inventor, or producer, claims, to be expressed in terms which will give the character of the design, &c.

Form of Oath.

County of Hampden, State of Massachusetts, ss:

On this day of 184 , before the subscriber a personally appeared the within named Sebastian Cabot, and made solemn oath, or affirmation, (as the case may be,) that he verily believes himself to be the original and first inventor, or producer, of the design for figures to be printed on fabrics, which, when thus printed, are termed calicoes, and that he does not know, or believe, that the same was ever before known, or used, and that he is a citizen of the United States.

(Signed) A. B.

The phraseology of the title of this act having misled many per-

sons, it is proper to add that it is an act in addition to the act of July 4, 1836, by which act all acts and parts of acts before made, were *then* repealed. The title of the act of August 29, 1842, therefore, merely recites the title of the act of 1836.

HENRY L. ELLSWORTH,
Patent Office, Nov. 5, 1842. Commissioner of Patents.

All Communications should be addressed to the Commissioner of Patents.

In consequence of the numerous applications to this office for information, founded on brief descriptions of inventions, and asking, in any given case, whether there exists any thing like the invention described, and whether a patent can be had therefor, it has become necessary to furnish the explanation following, as a general reply to such inquiries.

By the act of July 4, 1836, entitled "An act to promote the useful arts, and to repeal all acts and parts of acts heretofore made for that purpose," a principle entirely new was engrafted upon the system, under which patents had been previously granted.

Under the provisions of this act, it was made the duty of the Commissioner of Patents, on the receipt of any application for a patent, to institute "an examination of the alleged new invention, or discovery," with the view to determine whether the same had been before "invented, or discovered, by any other person in this country," "or patented, or described, in any printed publication, in this, or any foreign, country." Thus was the grant of patents in future restricted to such "inventions, or discoveries," as were *new*, in the most absolute sense of the term; and a very laborious and responsible duty imposed upon this office. In aid of the solution of the question of *novelty*, thus raised on every application, the applicant was required to furnish a full and clear description of his invention, signed, witnessed, and verified by his oath, accompanied by a model and drawings of the same; all being deemed necessary in order to illustrate his claim to a patent. Furnished with these illustrations, the office was then required to go into a rigorous and extended examination, taking in the whole range of history on the given subject, whether its evidences were to be found in patents granted, caveats filed, or descriptions published, in this, or in any foreign, country, in any period of time.

In the conduct of these examinations, it is necessary to keep in constant and laborious employment, a number of persons specially selected for their knowledge and skill in the arts; to refer, with guarded care, to caveats filed in the secret archives of the office, and which can only come into view on such occasions; to patents already granted, and to such works on the arts as have been published here, or elsewhere; and also to keep pace with the current of invention throughout the world, by a constant and copious supply of such publications in this country and in Europe as are devoted to this object.

It will readily be seen that this office cannot undertake to respond

to the numerous inquiries constantly addressed to it, whether such, or such, an invention be new, and whether a patent can be obtained for it. Because, 1st, every such inquiry involves the *whole question of novelty;* and before the office could express, or even form, an opinion, would require the same range of rigorous examination as is now required by law on a regular application for a patent, and this too without the necessary illustrations; such inquiries being based on mere, and usually very imperfect, general descriptions; while, in the case of application for patents, the law requires that the office shall have the aid, not only of clear and full description, under oath, but also accurate drawings and models, before it shall decide the question whether, in any given case, the invention be *new,* &c.

2nd. The attempt to do so would effectually interrupt the appropriate business of the office, and be a direct infringement on the rights of those who apply for patents; as the regular examinations of their applications must necessarily be suspended, while the examinations required, in order to frame such answers, were being made.

3rd. Every such inquiry does, in effect, require this office to prejudge a case before such case is presented; or, in other words, the inquirer asks of the office to decide upon his invention before he has done that which the law requires he shall do, in order to obtain such decision.

4th. The law has made no provision for such services. It is, therefore, no part of the legitimate duty of this office.

It is hoped that this explanation will prove satisfactory to all, and that it will be distinctly understood, that, in declining to respond to the class of inquiries above stated, this office acts under the mere necessity of the case, and not from any disposition to withhold information.

The records and models of the office are always open to inspection, and copies can readily be furnished on receipt of the fee required by law.

Models.

SEC. 84. If deposited with any of the following agents, will be forwarded to the Patent Office, free of expense.

John N. Sherburne, Collector at Portsmouth, New Hampshire.
Nathan Cummings, Collector at Portland, Maine.
William P. Briggs, Collector at Burlington, Vermont.
William R. Watson, Collector at Providence, Rhode Island.
R. H. Eddy, Agent at Boston, Massachusetts.
Perry Smith, Surveyor at Hartford, Connecticut.
Edgar Irving, Agent, Custom House, New York.
Calvin Blyth, Collector at Philadelphia, Pennsylvania.
Nathaniel F. Williams, Collector at Baltimore, Maryland.
Thomas Nelson, Collector at Richmond, Virginia.
W. J. Grayson, Collector at Charleston, S. Carolina.
James Hunter, Collector at Savannah, Georgia.
T. Gibbs Morgan, Collector at New Orleans, Louisiana.
Edward Brooks, Collector at Detroit, Michigan.

J. H. Lathrop, Collector at Buffalo, New York.
Surveyor at St. Louis, Missouri.
William Milford, Collector at Cleveland, Ohio.
John Willock, Surveyor at Pittsburgh, Pennsylvania.
Isaiah Wing, Surveyor at Cincinnati, Ohio.
N. P. Porter, Surveyor at Louisville, Kentucky.

SEC. 85. The transmission of models by the agents extends to those for new applications, as well as those restored in consequence of the destruction of the originals.

SEC. 86. N. B.—*Patentees*, and the public in general, are urged to use their influence to aid the office in restoring the records of all patents and assignments on record before the fire in December, 1836. The same cannot be used in evidence, unless *so recorded anew.* No expense is incurred. The papers are received and transmitted by mail.

H. L. ELLSWORTH.
Commissioner of Patents.

List of Banks which are authorized to receive Patent Fees on account of the Treasury of the United States, and to give receipts, or certificates of deposit therefor, viz:

Merchants' Bank, at Boston, Massachusetts.
Arcade Bank, at Providence, Rhode Island.
Bank of Commerce, at New York.
Bank of the Metropolis, at Washington, D. C.
Bank of Washington, D. C.
Southwestern Railroad Bank, Charleston, S. C.
Louisville Savings Institution, Louisville, Ky.
Norwalk Bank, at Norwalk, Ohio.
Ohio Life Insurance and Trust Company, Cincinnati, Ohio.
Farmers and Mechanics' Bank, at Hartford, Ct.
Piscataqua Bank, at Portsmouth, N. Hampshire.
Exchange Bank, at Pittsburgh, Penna.
Bank of Missouri, at St. Louis, Missouri.
Merchants' Bank, at Baltimore, Maryland.
Philadelphia Bank, at Philadelphia, Penna.
Bank of America, at New York.
Union Bank of Tennessee, at Nashville, Tennessee.
Union Bank of Louisiana, at New Orleans, La.

Any person wishing to pay a patent fee may deposit it with either of the banks above named, and forward the receipt, or certificate, to this office, as evidence thereof.

Request.

Congress having authorized the collection and distribution of seeds through this office, a transmission to this place of any rare and useful seeds, may confer a great benefit on the community, and will, so far as practicable, be reciprocated by the Commissioner of Patents. A history of the seed transmitted, together with the place of production is respectfully solicited.

H. L. ELLSWORTH.

Mechanics, Physics, and Chemistry.

On Madder. By M. Girardin, *Prof. Pract. Chem. at the Municipal School of Rouen.*

(Continued from Page 340.)

V.—*On the Adulteration of Madders, and Methods of Detecting them.*

On account of the high price of madder, and especially from the facility of introducing into this substance, which is sold in the form of powder, foreign pulverulent matters, which the most practiced eye cannot detect, this root is subject to a number of sophistications which cannot be too fully exposed.

There are two kinds of adulteration. Sometimes earthy, or mineral, substances are incorporated with the powder of madder; sometimes vegetable substances are added to it, the color of which resembles that of madder.

1. *Adulteration by Mineral Substances.*—The mineral substances which have been introduced, or which are still found in ground madders, are brick dust, red and yellow ochre, yellowish sand, yellowish clay, or argillaceous earth. A madder which contains earthy substances grates between the teeth when chewed.

A small quantity of such a madder, for example, from 25 to 30 grms., introduced into a large glass globe, and diluted with 5 or 6 litres of water, quickly deposits the greater portion of the earthy substances at the bottom of the vessel. When the suspended madder is decanted, and the deposit agitated with a fresh quantity of water, the earthy substances are isolated, and may be examined.

However, to determine the proportion, more exact processes must be had recourse to. The best is that of calcining, at a red heat, in a platinum crucible.

5 grms. of the madder under examination, are first dried completely at 212° Fahrenheit, and are weighed with great exactness, and then put into the platinum crucible, which must be weighed before hand. The crucible is shut, and heat gradually applied. When perfectly incinerated, the crucible, is taken out of the furnace, and left to cool, and then weighed. Its weight being deducted from the quantity employed, the difference gives the proportion of cinders obtained.

These cinders are composed, 1st, of the fixed mineral matters contained in the root; and 2nd, of the earthy substances, foreign to the chemical constitution of the root, and which have been accidentally, or fraudulently, mixed with the madder.

Some experiments which I made with M. Labillardière on a large scale, in 1828, showed us that madder which is very pure, and quite free from its epidermis, or any foreign earthy matter, and dried with care, gives, by incineration, 5 per cent. of ash; that the Lizaris of Provence, stripped of its pellicle, gives, on an average, 8.80 per cent. of ash.

According to M. Henri Schlumberger, 100 parts of Alsatian Lizaris, washed in distilled water, and dried at 212°, give 7.20 per cent. of ash; whilst 100 parts of Lizaris of Avignon, prepared in the same way, give 8.766.

According to M. Chevreul, 100 parts of Lizaris, from the Levant, dried at 212°, give 9.80 ash.

When an Avignon madder, SFF (the mark most generally used,) subjected to the test of incineration, gives a greater weight of ash than 5 per cent., which I have taken as the mean of numerous experiments, the excess must be attributed to the presence of foreign earthy, or sandy, matters, either arising from adulteration, or a careless preparation of the powder.

When the excess is only from three to four-hundredths, it is probably owing to some fault in the preparation of the madder, the manufacturer not having separated the epidermis, which is always coated with the earth which surrounds the root, carefully enough by grinding; but when the excess is above 4 or 5 per cent., or more, it is the result of fraud.

The madders obtained from the merchants give very variable results, with respect to the proportion of ash which they furnish, as the following table shows:—

	Per Cent. of Ash.
On 6 trials the mulle madder of Avignon gave	4.00
On 7 trials the madder SF of Avignon gave from	12.40 to 20.00
On 18 trials the madder SFF of Avignon gave from	7.40 to 23.00
On 4 trials the madder SFFRP of Avignon gave from	12.00 to 16.00
On 3 trials the madder SFFP of Avignon gave from	10.00 to 10.80
On 7 trials the madder EXTF of Avignon gave	10.00

When, in testing a madder by incineration, the quantity operated on amounts to 5 grammes, the weight of the ash must be multiplied by 20, in order to bring it to 100 parts, and from the figure obtained 7 parts, representing the mean weight of ash p. c. furnished by good madder, subtracted; the surplus then represents the proportion of earthy matters, or of sand, added by the manufacturer. Consequently a madder furnishing 16.40 per cent. of ash will contain 9.40 per cent. of foreign matter.

2. *Adulteration by Vegetable Substances.*—The vegetable substances which are introduced into the madders, are powders of little, or no, value, such as saw dust, almond shells, bran, the bark of the so called pine tree, mahogany wood, log wood, sandal wood, and fir tree wood.

The sophistication of madders by these different substances, is much more prejudicial to the dyer than that by mineral substances; for, besides diminishing, like the latter, the quantity of coloring matter of a given weight of madder, they also injure the dye, either by absorbing the coloring matter, or by preventing the colors becoming so bright.

Unfortunately, the means of detecting this new kind of fraud are neither so rigorous nor so simple as the process for determining the presence of mineral matters. It is extremely difficult to ascertain

with what kind of vegetable substance a madder has been adulterated; it is mostly only possible to ascertain that there is a mixture. This, however, is the most important point, and the practical man, after all, only needs to know the tinctorial worth of the madder which he buys.

Many methods have been proposed to determine the tinctorial value of madders, and the absolute quantity of the coloring principle which they contain; but the greater part of them have the fault of being too exact, or too difficult, and too long of execution. I will now point out those which I think preferable, and which I have long since employed in the examination of madders which I continually make.

One of these means consists in determining the coloring power by means of Labillardière's colorimeter; the second, in determining this coloring power, as well as the solidity and brilliancy of the colors, by an operation of dyeing. The third experiment is to ascertain the absolute quantity of the coloring principle.

These different experiments are always made comparatively, by taking for type a madder prepared with all possible care, and having the same marks as that under examination. As with indigo and other tinctorial substances, a single experiment is not sufficient; and by reason of the difficulty there is of correctly verifying the value, or the quality, of the madders, it is indispensable, in order to decide with any certainty, to check the experiments by each other. This is the only way of obtaining satisfactory results.

1. *Determination of the Coloring Power by the Colorimeter.*—The following is the mode of operation with the colorimeter of Labillardière. The type madder, and the madder under examination, are dried at 262° Fahr., and an account is kept of the respective quantities of hygrometric water they contain.

25 grammes of each sample are then mixed with 250 grammes of water at 68°. After 3 hours of contact, the whole is thrown upon a linen cloth. A second maceration is made with the same amount of water, and for the same length of time. The madders are then washed with 250 grms. of cold water, dried at 212°, and weighed, in order to ascertain the proportions of soluble, saccharine, and mucilaginous matters which they have lost by these preliminary washings, which only remove an insignificant quantity of red coloring matter.

5 grms. of each of the two madders are then introduced into little glass globes with 40 parts of water, and 6 parts of very pure alum, boiled for a quarter of an hour, and the boiling liquids filtered. The grounds are washed with 2 parts of hot water. Two other decoctions, similar to the first, are made, and each time the residue is washed with 2 parts of hot water. The products of the three decoctions are combined, and the liquids from the two samples of madder compared by the colorimeter.

Without doubt this examination with the colorimeter is not sufficiently accurate, but it affords valuable indications, which, joined to those resulting from the following tests, enable us to give a decided opinion.

2. *Determination of the Tinctorial Power by Dyeing.*—In order to estimate the value of a madder by dyeing, a madder of superior quality must be taken, as a type of comparison, with which skains, or mordanted calicoes, have been already dyed, by acting with determinate quantities of powder, tissue, and water. Patterns for comparison should be prepared in the following manner:—

Calicoes are selected, mordanted for red and black, and well cleansed in a dung bath. They are divided into pieces 5 centimetres square, and are dyed with proportions of madder increasing progressively from 1 grm. up to 10 grms., so as to have a scale of 10 shades, of which the gradations represent each a known weight of madder. The garancing of these pieces is practiced in the following manner: In a great copper basin, with a flat bottom, which is covered with a layer of hay, are placed three or four glass jars with wide mouths, containing from 1¼ litre to 2 litres. The basin is filled with ordinary water heated to 104°, then into each of the glass jars the piece of mordanted calico is introduced, the madder weighed with care, and lastly, three-fourths of a litre of distilled water, heated to a temperature of 104°. A thermometer is inserted in the water bath, which is heated slow enough for the water not to reach 167°, until after an hour and a half, avoiding carefully alternations of temperature. After this is made to boil for half an hour, the samples are taken out, rinsed in cold water, and dried. Each dyed piece is cut in half; one-half is preserved as it is, the other is subjected to the following clearings:— We begin by a soap bath at 122°, made with 2½ grms. of white soap, to each litre of water. After it has been half an hour in this bath, the cloth is carefully rinsed in cold water. A fresh soap bath is given, to which is added half a gramme of salt of tin, and which is kept at a boiling point for half an hour. It is washed and rinsed. The well rinsed samples are dried with care, and preserved from the light.

When a series of tints of two different states have been thus prepared, that is to say, a dye without and with clearing, it is very easy to ascertain the comparative value of an unknown madder. In fact, it is sufficient to take 10 grms. from the barrels, and to go through the preceding operations on 5 square centimetres of suitably mordanted calico, and to compare the dye obtained, before and after the clearing, with the ten samples. If, for example, the shade is equivalent to No. 5 of the madder, it may be concluded that the unknown madder is inferior by half to the madder type, since $10:5::100:x=50$.

Whatever vegetable powders may have been fraudulently introduced into the madders, whether tinctorial, or inert, they can never lead to error as to the true tinctorial value of the mixture, inasmuch as the colors which they afford, and which saturate the mordants at the same time as the red principle of the madder, cannot withstand the action of the clearings as the latter does; they *run*, as is said, in the soap and tin baths, and in the end there only remains the color from the madder upon the tissue. The clearings are, therefore, necessary to show the solidity and vivacity of the tints obtained.

Instead of printed calicoes, skains of oiled and mordanted cotton may be used in the state in which they are prepared for dyeing

Turkey red. In this case skains of the weight of 10 grms. are taken, and dyed with different weights of good madder, from 20 to 30 grms., in order to obtain a scale of ten distinct shades.

This test is that which I have employed since 1831, and which has been since adopted in all our print works of Rouen and Bolbec, where my pupils have introduced it. It differs very little from that which was published in 1835, by M. H. Schlumberger of Mulhausen.*

3. *Determination of the Quantity of the Coloring Principle.*—The most exact process hitherto published, is, without doubt, that made known by M. H. Schlumberger in 1838,† as modified by M. Scheurer.‡ But this process, which is founded on the solubility of the red coloring principle of the madder in weak acetic acid, a fact pointed out as early as 1829, by an anonymous chemist,‖ is, unfortunately, too sensitive, and requires too great a degree of skill in the manipulation, to become general.

The following is the method which I have long been accustomed to employ:—50 grms. of madder are diluted with 50 grms. of concentrated sulphuric acid. The whole is left in contact for some hours: too high a temperature should be avoided; the charcoal obtained is mixed with water, and thrown upon a filter; it is then washed until the water passes through quite insipid; and next dried at a temperature of 212° Fahr., in Gay-Lussac's water bath. This charcoal is reduced to a fine powder, and macerated for two hours at three distinct intervals, with cold alcohol containing a little ether, in order to free it from a fatty matter which it retains. The powder is boiled in alcohol of 0.834, at three different intervals, employing each time about 250 grms. of alcohol. When this is no longer colored by ebullition, the alcoholic liquors are mixed, and distilled in a small glass retort to the consistence of a sirop, and the concentration of the liquid completed in the water bath in a weighed porcelain crucible. When the extract is perfectly dry, its weight is taken. This represents the proportion of red tinctorial principle contained in the madder.

This process is rather long; it does not give, especially on a small scale, the absolute proportion of coloring principle contained in the madder; there is a slight loss, but by acting comparatively a sufficient approximation is obtained.

Such are the different methods for ascertaining the quality, the purity, or the adulteration, of the madders. In most cases calcination is sufficient, and rigorously, calcination and the test by dyeing made conjointly, allow the practitioner to form a positive opinion of the value of the madders submitted to examination.

Considering the minutiæ, and the number of operations which it is necessary to have recourse to, in order to form a just estimate of the relative worth of the madders, it is evident that an examination of the madders by simply looking at them, as is customary with the merchants, can afford no precise information, and must, indeed, lead, in most cases, to erroneous conclusions. The process in use amongst merchants consists in spreading samples of madders of about 30 to 40

* Bulletin de la Société Industrielle de Mulhausen, viii, p. 300.
† Id., xi, p. 323. ‡ Id., xi, p. 339. ‖ Id., ii, p. 407.

grammes side by side on a sheet of paper, which small heaps are flattened, and their surfaces rendered smooth with the back of an ivory spatula. The samples are then placed in a cellar, or some moist situation, where they remain from twelve to fifteen hours. At the expiration of this time the quality is judged of according to the brightness and tint of the powder.

But as M. H. Schlumberger* has already observed, this method does not even approximately show the richness of color of the madders, since a somewhat long contact with the air is sufficient to render them darker, and many circumstances may change their tint, without thereby causing their tinctorial value to vary. On the other hand, the old madders, of a dull tint, may be far superior to others of a more beautiful color. The merchants' and brokers' method of trial often places the manufacturer in a false position, by obliging him to brighten the tint of his powders, in order to make them more saleable, and that sometimes to the injury of the tinctorial power; thus facilitating the adulteration of the madders by mixture with foreign substances, suitably colored and pulverized, which serve to heighten the tint of the powder; and it is impossible to ascertain the presence of these mixtures by exposure in the cellar, of which I have often had proofs. I have purposely made mixtures of madder, of powders of mahogany and of sandal wood in known proportions, and these mixtures, when tried by the merchants, who thought themselves very skilful in their estimation of madders, by the above process, were considered by them to be pure madders of first quality!

Testing of the Garancines.—The quality of the garancines varies, as I have already stated, considerably. A manufacturer sometimes sends a series of from fifteen to twenty barrels of excellent quality, and fifteen days later sends another series which is worth from 20 to 25 per cent. less than the preceding one. It often happens that in the same series good and bad garancine is found; each barrel, therefore, of this product should be tested comparatively, as far as possible. It is now customary for the seller to take back the garancines which he had delivered to the calico printer, allowing for the pieces spoiled, when the quality of the powders was inferior to what it was represented.

The testing of garancines is made on a large and on a small scale. In the latter case the following is the process we adopt:—

Samples are taken from the barrels as they arrive, taking care to cork the labeled bottles in which they are inclosed as quickly as possible, in order that they may not dry, which, in summer time especially, causes an amelioration of from 5 to 6 per cent. in a few days, on account of the water which evaporates.

A piece of calico, printed in stripes of red, violet, puce, and garnet, is taken, (black is useless, as all the garancines produce that well,) not gummed as usual, and dried. As many decimetres are cut from it as there are garancines to be tried, and the pieces are marked by notching them with the scissors: the notches must correspond with the numbers on the bottles.

* Bulletin de la Société de Mulhausen, xi, p. 313.

From 1.9 grm. to 2 grms. of garancine, known to be good, is weighed off to serve as a standard, and for the garancines to be tried, we take 1, 2, 3, 4, 5, 6, 7, 8, 10 times, more, or less, of 1.90, or 2 grammes, according as they cost, 1, 2, 3, 4, &c., more, or less, than the standard sample. As the samples are weighed, they are each put into a jug with a wide mouth holding half a litre, with from 2 to 2½ decilitres of water containing some oxalic acid, in the proportion of 15 centigrammes to a litre. The jugs are numbered so as to correspond with the samples of the garancines and strips of calico. They are placed in a water bath, in a copper boiler with a flat bottom, the pieces of printed calico are immersed in them, and dyed as in testing the madders, regulating the fire so as to raise the temperature to 158° in an hour and a half, and keeping it at the boiling point for half an hour. After the process of dyeing, the samples are removed as quickly as possible from the vessels, rinsed in water, and beaten, and then dried, or previously immersed for five or six minutes in a bran bath at 167°. When dry they are compared, and in this manner the relative tinctorial value of the garancines may be estimated as nearly as possible.

In employing calicoes, which present at the same time stripes mordanted for red, violet, puce, and garnet, it is seen at once whether the garancines can be employed with advantage for all the colors, or for what tints they are most suited. I have already stated that the same garancine does not always suit equally well for red, puce, and violet. —*Journ. de Pharm. for Nov. and Dec.*, 1843.

London Chemical Gazette.

A speculation touching Electric Conduction, and the Nature of Matter. *By* Michael Faraday, Esq., D. C. L., F. R. S.

Last Friday I opened the weekly evening meetings here, by a subject of which the above was the title, and had no intention of publishing the matter further, but as it involves the consideration and application of a few of those main elements of natural knowledge, facts, I thought an account of its nature and intention might not be unacceptable to you, and would, at the same time, serve as the record of my opinion and views, as far as they are at present formed.

The view of the atomic constitution of matter, which, I think, is most prevalent, is that which considers the atom as a something material having a certain volume, upon which those powers were impressed at the creation, which have given it, from that time to the present, the capability of constituting, when many atoms are congregated together into groups, the different substances whose effects and properties we observe. These, though grouped and held together by their powers, do not touch each other, but have intervening space, otherwise pressure, or cold, could not make a body contract into a smaller bulk, nor heat, or tension, make it larger; in liquids these atoms, or particles, are free to move about one another, and in vapors, or gases, they are also present, but removed very much further apart, though still related to each other by their powers.

The atomic doctrine is greatly used one way or another in this, our day, for the interpretation of phenomena, especially those of crystallography and chemistry, and is not so carefully distinguished from the facts, but that it often appears to him who stands in the position of student, as a statement of the facts themselves, though it is at best but an assumption; of the truth of which we can assert nothing, whatever we may say, or think, of its probability. The word atom, which can never be used without involving much that is purely hypothetical, is often *intended* to be used to express a simple fact, but, good as the intention is, I have not yet found a mind that did habitually separate it from its accompanying temptations; and there can be no doubt that the words definite proportions, equivalents, primes, &c., which did and do express fully all the *facts* of what is usually called the atomic theory in chemistry, were dismissed because they were not expressive enough, and did not say all that was in the mind of him who used the word atom in their stead; they did not express the hypothesis as well as the fact.

But it is always safe and philosophic to distinguish, as much as is in our power, fact from theory; the experience of past ages is sufficient to show us the wisdom of such a course; and, considering the constant tendency of the mind to rest on an assumption, and, when it answers every present purpose, to forget that it is an assumption, we ought to remember that it, in such cases, becomes a prejudice, and inevitably interferes, more, or less, with a clear sighted judgment. I cannot doubt but that he who, as a mere philosopher, has most power of penetrating the secrets of nature, and guessing by hypothesis at her mode of working, will also be most careful, for his own safe progress, and that of others, to distinguish that knowledge which consists of assumption, by which I mean theory and hypothesis, from that which is the knowledge of facts and laws; never raising the former to the dignity, or authority, of the latter, nor confusing the latter, more than is inevitable, with the former.

Light and electricity are two great and searching investigators of the molecular structure of bodies, and it was whilst considering the probable nature of conduction and insulation in bodies not decomposable by the electricity to which they were subject, and the relation of electricity to space contemplated as void of that which by the atomists is called matter, that considerations something like those which follow were presented to my mind.

If the view of the constitution of matter, already referred to, be assumed to be correct, and I may be allowed to speak of the particles of matter, and of the space between them, (in water, or in the vapor of water, for instance,) as two different things, then space must be taken as the only continuous part, for the particles are considered as separated by space from each other. Space will permeate all masses of matter in every direction like a net, except that in place of meshes it will form cells, isolating each atom from its neighbors, and itself only being continuous.

Then take the case of a piece of shellac, a non-conductor, and it would appear at once from such a view of its atomic constitution,

that space is an insulator, for if it were a conductor the shellac could not insulate, whatever might be the relation as to conducting power of its material atoms; the space would be like a fine metallic web penetrating it in every direction, just as we may imagine of a heap of siliceous sand, having all its pores filled with water; or, as we may consider, of a stick of black wax, which, though it contains an infinity of particles of conducting charcoal diffused through every part of it, cannot conduct, because a non-conducting body (a resin) intervenes, and separates them one from another, like the supposed space in the shellac.

Next take the case of a metal, platinum, or potassium, constituted, according to the atomic theory, in the same manner. The metal is a conductor; but how can this be, except space be a conductor? for it is the only continuous part of the metal, and the atoms not only do not touch, (by the theory) but, as we shall see presently, must be assumed to be a considerable way apart. Space, therefore, must be a conductor, or else the metals could not conduct, but would be in the situation of the black sealing wax referred to a little while ago.

But if space be a conductor, how then can shellac, sulphur, &c., insulate? for space permeates them in every direction. Or if space be an insulator, how can a metal, or other similar body conduct?

It would seem, therefore, that in accepting the ordinary atomic theory, space may be proved to be a non-conductor in non-conducting bodies, and a conductor in conducting bodies, but the reasoning ends in this, a subversion of that theory altogether; for if space be an insulator it cannot exist in conducting bodies, and if it be a conductor it cannot exist in insulating bodies. Any ground of reasoning which tends to such conclusions as these, must, in itself, be false.

In connexion with such conclusions we may consider shortly what are the probabilities that present themselves to the mind, if the extension of the atomic theory which chemists have imagined, be applied in conjunction with the conducting powers of metals. If the specific gravity of the metals be divided by the atomic numbers, it gives us the number of atoms, upon the hypothesis, in equal bulks of the metals. In the following table the first column of figures expresses nearly the number of atoms in, and the second column of figures the conducting power of, equal volumes of the metals named:—

Atoms.		Conducting Power.
1.00	gold	6.00
1.00	silver	4.66
1.12	lead	0.52
1.30	tin	1.00
2.20	platinum	1.04
2.27	zinc	1.80
2.87	copper	6.33
2.90	iron	1.00

So here iron, which contains the greatest number of atoms in a given bulk, is the worst conductor excepting one. Gold, which contains the fewest, is nearly the best conductor; not that these conditions

are in inverse proportions, for copper, which contains nearly as many atoms as iron, conducts better still than gold, and with above six times the power of iron. Lead, which contains more atoms than gold, has only about one-twelfth of its conducting power; lead, which is much heavier than tin, and much lighter than platina, has only half the conducting power of either of these metals. And all this happens amongst substances which we are bound to consider, at present, as elementary, or simple. Whichever way we consider the particles of matter, and the space between them, and examine the assumed constitution of matter by this table, the results are full of perplexity.

Now let us take the case of potassium, a compact metallic substance with excellent conducting powers, its oxide, or hydrate, a non-conductor; it will supply us with some facts having very important bearings on the assumed atomic construction of matter.

When potassium is oxidized an atom of it combines with an atom of oxygen to form an atom of potassa, and an atom of potassa combines with an atom of water, consisting of two atoms of oxygen and hydrogen, to form an atom of hydrate of potassa, so that an atom of hydrate of potassa contains four elementary atoms. The specific gravity of potassium is 0.865, and its atomic weight 40; the specific gravity of cast hydrate of potassa, in such state of purity as I could obtain it, I found to be nearly 2, its atomic weight 57. From these, which may be taken as facts, the following strange conclusions flow. A piece of potassium contains less potassium than an equal piece of the potash formed by it and oxygen. We may cast into potassium oxygen atom for atom, and then again both oxygen and hydrogen in a two fold number of atoms, and yet, with all these additions, the matter shall become less and less, until it is not two-thirds of its original volume. If a given bulk of potassium contains 45 atoms, the same bulk of hydrate of potassa contains 70 atoms nearly *of the metal potassium*, and, besides that, 210 atoms more of oxygen and hydrogen. In dealing with assumptions I must assume a little more, for the sake of making any kind of statement; let me, therefore, assume that in the hydrate of potassa the atoms are all of one size, and nearly touching each other, and that in a cubic inch of that substance there are 2800 elementary atoms of potassium, oxygen, and hydrogen; take away 2100 atoms of oxygen and hydrogen, and the 700 atoms of potassium remaining will swell into more than a cubic inch and a half, and if we diminish the number until only those containable in a cubic inch remain, we shall have 430, or thereabout. So a space which can contain 2800 atoms, and amongst them 700 of potassium itself, is found to be entirely filled by 430 atoms of potassium as they exist in the ordinary state of that metal. Surely then, under the suppositions of the atomic theory, the atoms of potassium must be very far apart in the metal, *i. e.* there must be much more of space than of matter in that body: yet it is an excellent conductor, and so space must be a conductor; but then what becomes of shellac, sulphur, and all the insulators? for space must also, by the theory, exist in them.

Again, the volume which will contain 430 atoms of potassium, and

nothing else, whilst in the state of metal, will, when that potassium is converted into nitre, contain very nearly the same number of atoms of potassium, *i. e.* 416, and also then seven times as many, or 2912 atoms of nitrogen and oxygen besides. In carbonate of potassa the space which will contain only the 430 atoms of potassium as metal, being entirely filled by it, will, after the conversion, contain 256 atoms more of potassium, making 686 atoms of that metal, and, in addition, 2744 atoms of oxygen and carbon.

These and similar considerations might be extended through compounds of sodium, and other bodies, with results equally striking, and, indeed, still more so, when the relations of one substance, as oxygen, or sulphur, with different bodies, are brought into comparison.

I am not ignorant that the mind is most powerfully drawn by the phenomena of crystalization, chemistry, and physics, generally, to the acknowledgment of centres of force. I feel myself constrained, for the present, hypothetically, to admit them, and cannot do without them, but I feel great difficulty in the conception of atoms of matter, which, in solids, fluids, and vapors, are supposed to be more, or less, apart from each other, with intervening space not occupied by atoms, and perceive great contradictions in the conclusions which flow from such a view.

If we must assume at all, as indeed in a branch of knowledge like the present we can hardly help it, then the safest course appears to be to assume as little as possible, and in that respect the atoms of Boscovich appear to me to have a great advantage over the more usual notion. His atoms, if I understand aright, are mere centres of forces, or powers, not particles of matter, in which the powers themselves reside. If, in the ordinary view of atoms, we call the particle of matter away from the powers *a*, and the system of powers, or forces, in and around it *m*, then in Boscovich's theory, *a* disappears, or is a mere mathematical point, whilst, in the usual notion, it is a little unchangeable, impenetrable piece of matter, and *m* is an atmosphere of force grouped around it.

In many of the hypothetical uses made of atoms, as in crystalography, chemistry, magnetism, &c., this difference in the assumption makes little or no alteration in the results, but in other cases, as of electric conduction, the nature of light, the manner in which bodies combine to produce compounds, the effects of forces, as heat, or electricity, upon matter, the difference will be very great.

Thus, referring back to potassium, in which as a metal the atoms must, as we have seen, be, according to the usual view, very far apart from each other, how can we for a moment imagine that its conducting property belongs to it, any otherwise than as a consequence of the properties of the space, or, as I have called it above, the *m*? so also its other properties in regard to light, or magnetism, or solidity, or hardness, or specific gravity, must belong to it, in consequence of the properties, or forces, of the *m*, not those of the *a*, which, without the forces, is conceived of as having no powers. But then surely the *m* is the *matter* of the potassium, for where is there the least ground,

(except in a gratuitous assumption) for imagining a difference in kind between the nature of that space midway between the centres of two contiguous atoms, and any other spot between these centres? a difference in degree, or even in the nature of the power consistent with the law of continuity, I can admit, but the difference between a supposed little hard particle, and the powers around it, I cannot imagine.

To my mind, therefore, the *a*, or nucleus, vanishes, and the substance consists of the powers, or *m;* and, indeed, what notion can we form of the nucleus independent of its powers? all our perception and knowledge of the atom, and even our fancy, is limited to ideas of its powers: what thought remains on which to hang the imagination of an *a*, independent of the acknowledged forces? A mind just entering on the subject, may consider it difficult to think of the powers of matter independent of a separate something to be called *the matter*, but it is certainly far more difficult, and indeed impossible, to think of, or imagine, that *matter* independent of the powers. Now the powers we know and recognize in every phenomena of the creation, the abstract matter in none; why then assume the existence of that of which we are ignorant, which we cannot conceive, and for which there is no philosophical necessity?

Before concluding these speculations I will refer to a few of the important differences between the assumption of atoms consisting merely of centres of force, like those of Boscovich, and that other assumption of molecules of something specially material, having powers attached in and around them.

With the latter atoms, a mass of matter consists of atoms and intervening space; with the former atoms, matter is everywhere present, and there is no intervening space unoccupied by it. In gases the atoms touch each other just as truly as in solids. In this respect the atoms of water touch each other whether that substance be in the form of ice, water, or steam; no mere intervening space is present. Doubtless the centres of force vary in their distance one from another, but that which is truly the matter of one atom touches the matter of its neighbors.

Hence matter will be *continuous* throughout, and in considering a mass of it we have not to suppose a distinction between its atoms, and any intervening space. The powers around the centres give these centres the properties of atoms of matter; and these powers again, when many centres by their conjoint forces are grouped into a mass, give to every part of that mass the properties of matter. In such a view all the contradiction resulting from the consideration of electric insulation and conduction disappears.

The atoms may be conceived of as highly *elastic*, instead of being supposed excessively hard and unalterable in form; the mere compression of a bladder of air between the hands can alter their size a little; and the experiments of Cagniard de la Tour carry on this change in size until the difference in bulk at one time and another may be made several hundred times. Such is also the case when a solid, or a fluid, body is converted into vapor.

With regard also to the *shape* of the atoms, and, according to the

ordinary assumption, its definite and unalterable character, another view must now be taken of it. An atom by itself might be conceived of as spherical, or spheroidal, or where many were touching in all directions, the form might be thought of, as a dodecahedron, for any one would be surrounded by, and bear against, twelve others, on different sides. But if an atom be conceived to be a centre of power, that which is ordinarily referred to under the term *shape*, would now be referred to the disposition and relative intensity of the forces. The power arranged in and around a centre might be uniform in arrangement and intensity in every direction outwards from that centre, and then a section of equal intensity of force through the radii would be a sphere; or the law of decrease of force from the centre outwards might vary in different directions, and then the section of equal intensity might be an oblate, or oblong, spheroid, or have other forms; or the forces might be disposed so as to make the atom polar; or they might circulate around it equatorially, or otherwise, after the manner of imagined magnetic atoms. In fact nothing can be supposed of the disposition of forces in, or about, a solid nucleus of matter, which cannot be equally conceived with respect to a centre.

In the view of matter now sustained as the lesser assumption, matter and the atoms of matter would be mutually penetrable. As regards the mutual penetrability of matter, one would think that the facts respecting potassium and its compounds, already described, would be enough to prove that point to a mind which accepts a fact for a fact, and is not obstructed in its judgment by preconceived notions. With respect to the mutual penetrability of the atoms, it seems to me to present, in many points of view, a more beautiful, yet equally probable and philosophic idea of the constitution of bodies than the other hypotheses, especially in the case of chemical combination. If we suppose an atom of oxygen, and an atom of potassium about to combine and produce potash, the hypothesis of solid, unchangeable, impenetrable atoms places these two particles side by side in a position, easily, because mechanically, imagined, and not unfrequently represented; but if these two atoms be centres of power they will mutually penetrate to the very centres, thus forming one atom, or molecule, with powers, either uniformly around it, or arranged as the resultant of the powers of the two constituent atoms; and the manner in which two, or many, centres of force may in this way combine, and afterwards, under the dominion of stronger forces, separate again, may, in some degree, be illustrated by the beautiful case of the conjunction of two sea waves of different velocities into one, their perfect union for a time, and final separation into the constituent waves, considered, I think, at the meeting of the British Association at Liverpool. It does not, of course, follow, from this view, that the centres shall always coincide; that will depend upon the relative disposition of the powers of each atom.

The view now stated of the constitution of matter would seem to involve, necessarily, the conclusion that matter fills all space, or, at least, all space to which gravitation extends, including the sun and its system; for gravitation is a property of matter dependent on a certain

force, and it is this force which constitutes the matter. In that view matter is not merely mutually penetrable, but each atom extends, so to say, throughout the whole of the solar system, yet always retaining its own centre of force. This, at first sight, seems to fall in very harmoniously with Mossotti's mathematical investigations, and reference of the phenomena of electricity, cohesion, gravitation, &c., to one force in matter; and also again with the old adage, "matter cannot act where it is not." But it is no part of my intention to enter into such considerations as these, or what the bearings of this hypothesis would be on the theory of light, and the supposed ether. My desire has been rather to bring certain facts from electrical conduction and chemical combination to bear strongly upon our views regarding the nature of atoms and matter, and so to assist in distinguishing in natural philosophy our real knowledge, *i. e.* the knowledge of facts and laws, from that, which, though it has the form of knowledge, may, from its including so much that is mere assumption, be the very reverse.

Royal Institution, January 25th, 1844.

Lond. Edin. and Dub. Philos. Mag.

Coal Formation of Nova Scotia. From ABRAHAM GESNER'S *Memoir on the Geology of Novia Scotia.*

Unless the calcareous deposits of the districts of Pictou and Stewiack should be found to belong to the carboniferous limestone of New Brunswick and Great Britain, the author is not aware that there are any beds in the province which are referable to that formation. The coal field which skirts nearly the whole of the northern coast of Nova Scotia, and which occupies the greater part of the isthmus, is a small part of that extensive coal field of which the remainder is situated in the province of New Brunswick. In Nova Scotia, the commencement of the coal field towards the east is near Pomket Harbor, between the 45th and 46th parallels of north latitude, and the 61st and 62nd meridians of west longitude. Hence it extends along the whole northern coast of the province of Nova Scotia to Bay Verte, where it enters the province of New Brunswick. The area of the coal field in Nova Scotia is about 2500 square miles, and that of the coal field in New Brunswick about 7500 square miles, making the total area of the coal field in the two provinces 10,000 square miles, and in this computation is not included the coal field of Cape Breton. The above coal field may, therefore, be considered as one of the most extensive on the face of the globe, and as of great value to Great Britain, and her North American colonies. The strata occupying this extensive area consist

1. Of gray, red, and chocolate colored sandstones and conglomerates;
2. Of red, blue, and black shales;
3. Of shelly lime stones;
4. Of clay iron stone;

5. Of coal, of which the bituminous variety occurs throughout the district.

All the strata abound in the remains of the plants that are usually found in the coal measures.

The coal measures usually lie in long parallel troughs, or in circular basins, towards the bottoms of which troughs, or basins, the strata dip in opposite directions. The prevailing strike of the strata is from south-west to north-east, which is also that of the more ancient slate rocks of Nova Scotia. The dip of the coal measures varies from 5° to 45°. Throughout the whole of the coast line, from Pomket Harbor to Point Miscou, the coal measures undergo scarcely any fault, or dislocation.

From Pictou Harbor, in Northumberland Strait, a belt of coal measures, about six miles broad, runs in a westerly direction across the isthmus, passing between the southern flank of the Cobequial mountains, and the southern coast of the isthmus, along the Basin of Mines, and thence running further westward to Advocate Harbor. The length of this belt is about 100 miles; the strata which compose it rest along the northern margin of the great part of the belt, on the fossiliferous slates of the Cobequial mountain; it is along its southern margin, that at Moose River and Advocate Harbor, the coal strata rest unconformably on old red sand stone. At Moose River the coal measures contain a thin bed of marine lime stone, and like the old red sand stone which they rest upon, thin beds of gypsum. The coal measures lap round the eastern extremity, and pass along the northern flank of the fossiliferous slates of the Cobequial range; whence they pass nearly due west to Apple River, on Chignecto Bay. All the isthmus north of this line consists of coal measures.

The Nova Scotian, or south-eastern coast of Chignecto Bay, runs nearly at right angles to the direction of the coal strata, and presents an admirable section of them nearly thirty-five miles in length. Along this length of coast the strata lie in a trough, the base, or synclinal, point, of which is Little Shoolie; and from this point, as you recede further in a north-eastern direction, the strata rise to the north and north-north-west, with an increasing dip. At the Joggins, twelve miles north-east of Little Shoolie, where the blue sand stone is extensively worked for grind-stones, the dip is from 25° to 35°. In the opposite direction, as you recede from the base of the trough, the strata rise towards the south, until on approaching the intrusive rocks of Cape Chignecto the inclination is 45°.

In making a careful examination of the entire of this coast of thirty-five miles, only one fault was observed, and that occasioned a dislocation of only a few feet. By measuring the horizontal distances between the strata, and making allowance for their inclination at a number of places, the author estimated the total thickness of the coal measures on this coast at not less than three miles.

The chief part of the workable seams of coal is probably exposed on the Chignecto shore, and it is near the middle of the section that most coal seams are seen. At the South Joggins, in the above coast section, in the horizontal distance of three quarters of a mile, and in

a thickness of strata amounting to 1800 feet, nineteen seams of coal are seen, from six inches to four feet thick. Outcrops of coal have been observed to the south-west of the Joggins, on the Apple River, and to the north-east on the river Hebert; also on the Macan river, where one seam is ten feet thick, and of good quality; and also near the river Philip. In the eastern part of the northern coast of the province coal first appears at Pomket; then at Fraser's mountain, and at the Albion mines, and other places near Pictou. In the belt of coal measures which lies south of the Cobequial mountain, two seams of coal have been discovered in the forest, ten miles north of Truro, dipping from that range. Outcrops of coal appear also in the same belt at Jolly river, at Debert river, at Economy river, and at Parr's Borough.

Along the northern coast which borders on Northumberland Strait, and along the courses of the rivers which fall into that Strait, coal plants are very abundant. Among these are many large trees which were branching at their tops. The bark is generally converted into coal, and sometimes the whole trunk; and then the woody fibre remains very distinct. Several of these trees are four feet in diameter, and some have been seen six feet in length. Along this coast the trees are all prostrate, whether in the sand stones, or shales, and they do not appear to lie more in one direction than another. On the coast of Chignecto Bay, fossil trees also abound; and in most places they lie in all positions, parallel to the strata, or across them obliquely. They always increase in number in the proximity of a seam of coal. In one part, however, of the Chignecto coast, called South Joggins, where the nineteen seams of coal, already mentioned, occur for the space of three-quarters of a mile, and in a thickness of strata amounting to 1800 feet, the fossil trees which occur are all perpendicular to the strata. In tracing these seams of coal along the ravines to the distance of six miles from the coast, trees have been observed in the same vertical position in respect of the strata. The cliffs at this spot are from 80 to 100 feet in height, and consist of gray and reddish sand stone, bituminous blue shale, shelly lime stone, clay iron stone, and coal. The strata are rapidly degraded, so that at every successive visit which the author has made to the spot, during the last ten years, he found that trees which he had originally observed had disappeared, and that others were exposed in their steed. At the last visit he made, which was in July last, in company with Mr. Lyell, seventeen trees were exposed to view, and this number was rather less than he had seen on former occasions. The ordinary length of these trunks is from 10 to 30 feet, but some have been observed that were 50, or even 70, feet long. They vary in diameter from 6 inches to 3 feet; but one was 4 feet 6 inches across. Most frequently their lower extremities are situated in shale; but sometimes they spring from the coal itself, and when that is the case, they never pass through the seam of coal. Sometimes their roots branch out into the shale, or sand stone, they rest upon.

At the place above referred to, ten miles north of Truro, the strata above and below the coal abound in trunks, branches, and leaves of

large fossil trees. The exterior of the trunks is coal; and the interior is usually sand stone and fine clay. In one tree the whole trunk was coal, except a flattened portion resembling the pith, and extending through the centre of the tree from one extremity to the other. At the spot on the Moose river, where the coal measures rest on old red sand stone, a fossil tree 30 inches in diameter, is seen in black shale, and dark colored sand stone.

Besides the coal district, already described, there is an area near Falmouth and Windsor, of seventy square miles, in which, though the coal has not been discovered, yet the ferns, *Stigmaria*, and other fossil plants which the sand stones and shales of that area contain, sufficiently establish the point that it belongs to the coal measures. Ibid.

Electro-Metallurgy. Historical and Practical Notices of the Art.

It is remarkable that chemistry has rarely presented society with a discovery of importance in the practical arts, which has not been more the result of accidental observation—of unexpected fact, eliminated in the course of investigations undertaken for objects of a different nature—than of direct inquiry, instituted for the purpose of arriving at the discovery. This, indeed, is to be expected. Chemistry, unlike mathematics, is not a science of reasoning; it is a science of observation and deduction, founded upon experiment. The history of the accidental discoveries which have been made in it, would, in effect, be a history of at least the early part of the science; and of the whole round of the chemical arts and manufactures. In the mean time, we confine our attention to one of its later bequests—to electro-metallurgy, which has already found extensive application in the hands of the practical man, and which, in point of history, affords a remarkable confirmation of the doctrine that no scientific fact is without its value.

Ever since the discovery, by Volta, of the voltaic pile—which is simply a multiplication of zinc and silver plates, separated by pieces of paper, or cloth, moistened in some saline, or dilute, acid solution—the attention of electro-chemists has been occupied with attempts to determine the arrangement best suited to produce, not only the most powerful, but likewise the most constant, current of electricity by chemical means. The different modifications proposed, are nearly as numerous as the experimenters; but although the results are to this extent unsatisfactory, we are indebted to the investigations, undertaken with a view to the establishment of accurate data of arrangement, for many interesting, and, at the same time, practically useful discoveries, altogether apart from the direct object of inquiry. None of the least of these, is the art of electro-metallurgy, which, notwithstanding its being a very recent addition to our practical knowledge, is familiar, at least in name, to every scientific reader. It has also its literature; but the treatises which have hitherto been given to the

public, although they contain much valuable information respecting its principles, leave us much room for a few practical papers, in which we intend to treat the subject more as an art than a philosophical question. It is not, however, our intention to avoid the discussion of its principles. On the contrary, while we are practical, we shall not overlook theory, on which all practice must be founded; and, in order that we may bring the *modus operandi* of the art fully before the reader, we think it expedient, in the first place, to give a concise statement of the fundamental principles upon which the art depends.

If a piece of metallic zinc be taken, and immersed in water acidulated with sulphuric, or muriatic, acid, the zinc is speedily dissolved; hydrogen gas is, at the same time, evolved from the decomposition of the water. This gas has a pungent smell, from the impurities in the metals employed. If pure metals were employed, this action of the acid would not proceed; but as pure metal cannot be obtained for ordinary use, the same effects in voltaic operations may be obtained, by taking the common zinc of commerce, after the acid has begun to act upon it, and rubbing a little mercury over its surfaces with a soft brush—the mercury combines with the zinc, and forms what is termed an amalgam upon its surface—or, in common language, the zinc plate is amalgamated.

If this amalgamated zinc be now put into the dilute acid, no action will be observed; if into the same acid solution be put a piece of clean copper, provided the metals do not touch, no more action is observed than if they were placed in as much water. But if we allow the copper and zinc to touch one another, either by the portions immersed, or out of the acid, hydrogen will be evolved from the surface of the copper, and that metal will appear being dissolved; but if the action be allowed to proceed for a short time, it will be observed from the corrosion of the zinc, that it is that metal, and not the copper, that is being dissolved. If, instead of causing the two metals to touch each other, they be connected by a very fine platinum, or steel, wire, this wire will become red hot from some "substance,' "agency," or "influence," which is passing from the copper through it to the zinc. This something is *electricity:* it is an electric current which has, in the first instance, been generated by the action of the solution upon the zinc; and, having passed through the solution to the copper, passes from thence through the wire to the zinc again. These two metals, thus arranged with the acid, constitute a galvanic battery of a single pair.

It was soon found by experience, that this kind of battery neither gives a long continued, nor a constant, current of electricity, from the following causes:—first, the hydrogen is not freely evolved from the surface of the copper plate; and, consequently, obstructing the influence of surface, affects materially the quantity of electricity obtained; and, secondly, a portion of the oxide, or chloride, of zinc, formed by the action of the acid upon the amalgamated zinc, being reduced and carried along with the hydrogen to the copper plate upon which it is deposited, forms a zinc surface upon the copper, which tends to transmit a current of electricity in the contrary direction; and, conse-

quently, to neutralize to some extent the original power of the circle. A few years ago, these disadvantages were, to a great extent, overcome by a very ingenious arrangement, discovered by Professor Daniell. The discovery consists in the separation of the zinc from the copper by a porous diaphragm; the portion containing the zinc is charged with dilute acid as before, but the portion containing the copper is filled with a solution of sulphate of copper. The action in this battery is similar to that described above; the zinc is dissolved by the acid, but the hydrogen, instead of being evolved at the copper plate, combines with the acid of the sulphate of copper; the metallic copper is thus set at liberty, and combines with the copper plate, not only maintaining, but improving its surface, during the evolution of a constant current of electricity. During experiments with this form of battery, Professor Daniell observed, that the copper deposited, when separated from the plate, contained inverse impressions of scratches which had been previously upon the plate; but the object of the experimenter had been fully attained, namely, the construction of a constant battery,* and the practical applications of the phenomenon of deposition were overlooked.

At this point the matter rested for several years, till towards 1838, when Mr. Thomas Spencer, of Liverpool, by a series of accidental circumstances, was led to think of the application of the decomposition of the copper, by electric action, to the multiplication of works of art—principally at first with a view to the formation of designs upon copper plates for printing—an idea from which has sprung the beautiful art of glyphography.

The following paragraph from Mr. Spencer's paper, read before the Liverpool Polytechnic Institution, announcing the discovery, will convey some notion of the seemingly trifling circumstance from which has sprung the art of electrotyping:—

"The members of the Society will recollect that, on the first evening it met, I read a paper upon the production of metallic veins in the crust of the earth, and that, among other specimens of cupreous crystalization which I produced on that occasion, I exhibited three coins—one wholly covered with metallic crystals, the others on one side only. It was used under the following circumstances:—When about to make the experiment, I had not a slip of copper at hand to form the negative end of my own arrangement; and, as a good substitute, I took a penny, and fastened it to one end of the wire, and put it in connexion with a piece of zinc, in the apparatus described, (a Daniell's battery.) Voltaic action took place, and the copper coin became covered with a deposition of metal in a crystaline form. But when about to make another experiment, and being desirous of using the piece of wire, used in the first instance, I pulled it off from the coin to which it was attached. In doing this, a piece of the deposited copper came off with it, and on examining the under portion, I found it contained an exact mould of a part of the head and letters of the coin, as smooth and sharp as the original on which it was deposited." This may be considered the history of the first electrotype, but still from the deposited metal being brittle, and other circumstances which

* A practical description of this battery will be given under the proper head.

probably had too much weight with Mr. Spencer, this electrotype, which ought to have been placed in the British Museum, was laid aside. Some time after this, Mr. Spencer accidentally dropping a little varnish upon a slip of copper upon which he was about to deposit, found that the deposit might be guided by such non-conducting substances over the surface; and finding also, by experience, that deposited metal is not necessarily brittle, but has its tenacity regulated by the electro current, thought of repeating the experiment with a coin in the same manner, that gave him the results just detailed. The result of this trial was a perfect electrotype. Being once successful, Mr. Spencer followed up his discovery with much vigor, surmounting many difficulties, and succeeded so far as to be able, in a short time, to furnish some excellent processes, by which medals and plates may be copied, and also means by which non-conducting substances, such as wood, wax, plaster, and the like materials, might also be coated.

We may mention here, that during the same time that Spencer was maturing his discovery, so as to bring it before the public, Professor Jacobi, of St. Petersburgh, announced a similar discovery; and, as in many other instances, the merit of the first discovery of this art, has, consequently, become a matter of dispute—both claiming precedence. From the evidence brought forward on the different sides, it would be a matter of some difficulty to decide to whom it most justly belongs.

The publication of Mr. Spencer's discovery acted like an electric shock upon society, and men, both of science and art, became active competitors in this new field of application; the one class anxious to bear away the honors arising from some important improvement—the other, the profits which might follow some novel application of the process to their own, or some other, branch of manufacture. With these combined efforts, it need not be wondered at, that in a very short time improvements of great scientific interest were pointed out, and applications of the greatest importance to the arts and manufactures of this country were introduced. In consequence, some of our old and standard manufactures, as we shall subsequently have occasion to notice at some length, have already begun to be revolutionized.

It may be necessary, in this historical sketch, to remark briefly those improvements which were introduced into electro-metallurgy by men of science. In general terms, these may be ranked under three heads: the first was the use of plumbago, or black lead, to give the surface of non-metallic bodies a conducting medium. This was the discovery of Mr. Murray, a gentleman of high attainments, and unassuming manner, who communicated the process to the members of the Royal Institution, orally. The Society of Arts afterwards awarded to Mr. Murray a silver medal, as an expression of their sense of the value of the discovery. This application at once freed electro-metallurgy from every bound; it was no longer necessary to use either metallic moulds, or moulds having metal reduced upon their surfaces by chemical means—which, according to the processes then known, was both a tedious and uncertain operation, and only

applicable to certain substances. Plumbago possessed all the requisite properties; it was plentiful, and, therefore, cheap; easily applied, and equally effective for every substance on which the electrotypist desired to obtain a deposit, or which he could wish to cover with metal, either for useful, or ornamental, purposes.

The next improvement of much importance was made by Mr. Mason, and consisted in the application of a separate battery. Previous to this discovery, what is termed the single cell process, was the only one used. It consisted in simply attaching the article to be deposited upon by a wire to a piece of zinc, and immersing the one into dilute acid, and the other into a solution of the metal to be deposited. The two liquids being divided by a porous diaphragm, constituted, as has already been observed, a battery of a single cell; but in this case, the whole electricity was expended within the cell to deposit the metal upon the mould. By Mr. Mason's discovery, the electricity generated in the cell could be made to do an equivalent of work in a separate cell as well,—making the original arrangement the generating cell, or battery, to the second cell. In this last was also a solution of a metal having in it a sheet of similar metal attached to the copper of the first, and the mould to be covered attached to the zinc of the first.

This process, with different forms of battery, will be described in detail in another part of these papers. It may, however, in the mean time be remarked, that many improvements of a minor kind followed those enumerated; but the last, and probably the most important in a manufacturing point of view, was introduced by Mr. Parkes, of Birmingham, to whom electro-metallurgists are much indebted. Instead of using plumbago, which, for large surfaces, has many objections, he takes wax, or better, a mixture of wax and rosin, or such other mixture as may be preferred for moulds, and mixes with it a solution of phosphorous in sulphuret of carbon—about one ounce of the former to four of the latter. He then takes a solution of nitrate of silver, about one ounce of this salt to four gallons of water. After the mould is obtained, it is put into this solution of nitrate of silver, (lunar caustic) and in a few minutes a thin film of silver is reduced upon its surface. The mould is then attached to the battery, and immersed in the copper solution; the deposit over every part of its surface is instantaneous, and does not grow over it, as is the case with plumbago. For coppering plastic terra cotta, wood, shells, flowers, leaves, and the like, the solution of phosphorous in sulphuret of carbon is admirably adapted. The article to be coated requires merely to be washed over with this solution, and immersed in the nitrate of silver solution; a thin film of the silver is immediately reduced upon its surface, and it is then ready to be put into the copper solution. We must, however, defer the more minute details, until we come to speak of the art of producing electrotypes.

The improvements here enumerated in connexion with the general law first pointed out by Mr. Spencer, and more fully developed and explained by Mr. Smee, and other experimenters, and which will be described in order—constitute the art of electro-metallurgy.

As might have been expected, during the general excitement which prevailed at the commencement of electro-metallurgy, each aspirant being actuated by different motives, viewed results in different lights. All the new results obtained, although isolated, were, in the hands of so many experimenters, soon reduced to a systematic whole. Honesty, we are sorry to add, did not uniformly characterize the progress of the art. The history, short as it is, is not wanting in instances of unjust appropriation of discoveries; or, viewing the progress of events in another light, we have instances of individuals becoming so engrossed with their own investigations, as to overlook the labors of others;—hurrying over a series of experiments they write a history of the art, and lay claim to a goodly share of the discoveries. As an example, we quote the following from a host of others:—

"The laws regulating the reduction of all metals in different states, were first given in this work as the result of my own discoveries. By these we can *throw* down gold, silver, platinum, palladium, copper, iron, and almost all other metals in three states, namely, as a black powder, as a crystaline deposit, or as a flexible plate. These laws appear to me at once to raise the isolated facts known as the electrotype into a science, and to add electro-metallurgy as an auxiliary to the noble arts of this country."—*Smee's Electro-Metallurgy.*

These are broad claims, and as broadly asserted; but, happening to know somewhat intimately the history of electro-metallurgy, and to have read a certain fable about a crow in peacock-dress, we are naturally led to inquire into the magnitude of Mr. Smee's claims to our gratitude a little more particularly—not for the purpose of detracting from the merits of any individual who labors to advance the cause of science, but with the honest intent of giving to all their due rights; knowing also, that if such statements as contained in the paragraph quoted, were well founded, it did not require the author to enumerate his claims so prominently. We think it no digression in a historical sketch, to trace how far these pretensions are just. The first in order, is the laws regulating the reduction of all metals.

"Law I.—The metals are invariably thrown down as a black powder, when the current of electricity is so strong, in relation to the strength of the solution, that hydrogen is evolved from the negative plate of the decomposition cell.

"Law II.—Every metal is thrown down in a crystaline state, when there is no evolution of gas from the negative plate, or no tendency thereto.

"Law III.—Metals are reduced in the reguline state, when the quantity of electricity, in relation to the strength of the solution, is insufficient to cause the production of hydrogen in the negative plate in the decomposition trough, and yet the quantity of electricity very nearly suffices to induce that phenomenon."

We will not here inquire whether these laws are strictly correct, as we will have occasion to examine the subject at length, in one of our forth-coming papers, but will, in the mean time, simply see what Mr. Spencer says of these laws. In his original paper announcing

the discovery, eighteen months previous to the publication of Mr. Smee's work, there is the following paragraph:—

"I discovered that the solidity of the metallic deposition depended entirely on the weakness, or intensity, of the electro-chemical action, which I knew I had in my power to regulate at pleasure, by the thickness of the intervening wall of plaster of Paris, and by the coarseness, or fineness, of the material. I made three similar experiments, altering the texture and thickness each time, by which I ascertained, that if the partitions were *thin* and *coarse*, the metallic deposition proceeded with great *rapidity*, but the crystals were friable and easily separated; on the other hand, if I made them thicker, and of a little finer material, the action was slower, but the metallic deposition was as solid and ductile as copper formed by the usual methods. Indeed, when the action was exceedingly slow, I have had a metallic deposition much harder than common sheet copper, but more brittle."

The identity of these laws requires no comment; and, comparing the circumstances of the one having nothing but the rude apparatus of a new born art suggested by himself, to that of the other, enjoying the advantages of eighteen months' improvements, Mr. Spencer is astonishingly correct.

The other claim in the paragraph, is being the father of the science of electro-metallurgy, and adding this science to the noble arts of this country. Unfortunately for the validity of this claim, patents had been previously taken out, both in this country and in France, for the application of it to the arts. Messrs. Elkington's patent for the application of the science to silvering and gilding—the most extensive application yet introduced—was published in full detail, and the manufacture was in extensive operation months before the publication of Mr. Smee's book.

We will not notice more of Mr. Smee's claims to discovery in this part of these papers, but must add, that the publication of his book gave an impulse to the study of electro-metallurgy; it is not only a goodly collection of the loose facts scattered throughout various periodicals, but contains besides a digest of a host of experiments made by himself, and these are very carefully and correctly detailed.

We may also observe, that a few months after the publication of Mr. Smee's work, Mr. Walker published a little manual upon electrotype manipulation, which, from its popular style and cheapness, did more to spread a knowledge of the art, and to attract the attention of all classes to it, than all the other publications put together.

In our next article we will describe what we have found in practice to be the best battery arrangement, and the method of proceeding to practice the art of electrotyping, both on a large and small scale. We will then proceed to the practical details of gilding and plating different metals by the electro process, as practiced by the different manufacturers engaged in the art throughout England and France.

Glasgow Mech. & Eng. Mag.

To be Continued.

On the manner in which Cotton unites with Coloring Matter. By Walter Crum, Esq., *Vice President of the Philosophical Society of Glasgow.*[*]

The effect of porous bodies in producing combination and decomposition, independently of chemical affinity, has, of late years, occupied considerable attention.

If we examine, says Professor Mitscherlich, a piece of box-wood by the microscope, we find it composed of cells which have a diameter of about $\frac{1}{2400}$th of an inch. Heated to redness, the form of these cells suffers no change, for the particles of which it is composed have no tendency to run together in fusion. A cubic inch of box-wood charcoal boiled for some time in water, absorbed five-eighths of its volume of that liquid; from which, and other data, it was computed that the surface of its pores was 73 square feet.

Saussure observed that a cubic inch of box-wood charcoal absorbed 35 cubic inches of carbonic acid; and as the solid part of the charcoal formed three-eighths of its bulk, these 35 inches of gas must have been condensed into five-eighths of an inch, or 56 cubic inches into one, under the ordinary pressure of the atmosphere. But carbonic acid liquefies under a pressure of 36.7 atmospheres, and, therefore, with a power of condensation equal to 56 atmospheres, which the charcoal exerted in Saussure's experiment, at least one-third of the gas must have assumed the liquid state within its pores.

Every other porous body has the same property as charcoal. Raw silk, linen, thread, the dried woods of hazel and mulberry, though they condense but a small quantity of carbonic acid, take up from 70 to 100 times their bulk of ammoniacal gas; and Saxon hydrophane, which is nearly pure silica, absorbs 64 times its bulk. The gases enter into no combination with the solid which absorbs them, for the air-pump alone destroys their union

The manner in which gases are attracted to the surfaces of solid bodies is very much like that which these exert on substances dissolved in water. The charcoal of bones has been long employed to remove coloring matter from the brown solution of tartaric acid, from sirop in the refining of sugar, and from a variety of other liquids containing organic substances; and it is found that the coloring matter so attracted remains attached to the surface of the charcoal without effecting any change upon it. In this animal charcoal the carbon is mixed with ten times its weight of phosphate of lime, and if that be washed away by an acid, the remaining charcoal has nearly twice the decolorating power of an equal weight of ivory-black. Bussy, who has made the action of these charcoals the subject of particular investigation, informs us that if ivory-black, after the extraction of its earth of bones by an acid, be calcined along with potash, and the potash be afterwards washed out, or if blood be at once calcined with carbonate of potash and washed, the remaining charcoal has the

[*] Read before the Philosophical Society of Glasgow, February 1, 1843; and communicated to this Journal by the author.

power of decolorating twenty times as much sirop as could be done by the original bone charcoal. Animal charcoal removes, also, lime from lime water, iodine from a solution of iodide of potassium, and metallic oxides from their solutions in ammonia and caustic potash.

A satisfactory explanation of these remarkable facts has yet to be sought for. Mitscherlich calls the force which produces them an action of contact, or attraction, of surface; and he calculates, as we have seen, the extent of surface in proportion to the mass as the measure of the force which it exerts. On the other hand, Saussure, in his valuable paper on the absorption of gases, informs us that charcoal from box-wood, in the solid state, absorbs twice as much common air as when it is reduced to powder. Now the effect of pulverization is certainly not to diminish the extent of surface. Saussure accounts for it in another way, and his explanation seems to connect many of the facts. The condensation of gases in solid charcoal goes on, he conceives, in the narrow cells of which it is composed, and is analogous to the rise of liquids in capillary tubes. In both, he says, the power appears to be in the inverse ratio of the size of the interior diameters of the pores, or tubes, of the absorbing bodies. When we pulverize a body containing such cells, we widen, open, and destroy them. Fir charcoal, whose cells are wide, absorbs 4¼ times its bulk of common air, and box-wood charcoal with smaller pores takes 7½. Charcoal from cork, with a specific gravity of only 0.1, absorbs no appreciable quantity.

It appears to me that many of the operations of dyeing depend upon this influence of the surface, or the capillary action described by Saussure.

The microscopic examination of the fibres of cotton by Mr. Thomson, of Clitheroe, and Mr. Bauer, shows them to consist of transparent glassy tubes, which, when unripe, are cylindrical, and in the mature state collapsed in the middle, from end to end, giving the appearance of a separate tube on each side of the flattened fibre.

In many of the operations of dyeing and calico printing, the mineral basis of the color is applied to the cotton in a state of solution in a volatile acid. This solution is allowed to dry upon the cloth, and in a short time the salt is decomposed, just as it would be in similar circumstances without the intervention of cotton. During the decomposition of this salt its acid escapes, and the metallic oxide adheres to the fibre so firmly as to resist the action of water applied to it with some violence. In this way does acetate of alumine act, and nearly in the same manner acetate, of iron. The action here can only be mechanical on the part of the cotton, and the adherence, as I shall endeavor to show, confined to the interior of the tubes of which wool consists. The metallic oxide permeates these tubes in a state of solution, and it is only when its salt is there decomposed, and the oxide precipitated and reduced to an insoluble powder, that it is prevented from returning through the fine filter in which it is then inclosed.

When the piece of cotton, which, in this view, consists of bags lined inside with a metallic oxide, is subsequently dyed with madder,

or log-wood, and becomes thereby red, or black, the action is purely one of chemical attraction between the mineral in the cloth, and the organic matter in the dye vessel, which together form the red, or black, compound that results; and there is no peculiarity of a chemical nature from the mineral constituent being previously connected with the cotton. The process of cleansing in boiling liquids, and in the wash-wheel, to which cotton printed with the various mordants is subjected, previous to being maddered, is to remove those portions of metallic oxide which have been left outside the fibres, or got entangled between them, and fastened there more, or less, firmly, by the mucilage employed to thicken the solution.

The view I have now given, is, in some respects, the old mechanical theory of dyeing held by Macquer, Hellot, and Le Pileur d'Apligny before the time of Bergman. Although unacquainted with the microscopic appearance of cotton, d'Apligny argued that as no vegetable substance in its growth can receive a juice without vessels proper for its circulation, so the fibres of cotton must be hollow within. And of wool, he says, the sides of the tubes must be sieves throughout their length, with an infinity of lateral pores. We may gather also that he conceived dyeing to consist, first, in removing a medullary substance contained in the pores of the wool, and afterwards depositing in them particles of a foreign coloring matter.

But Bergman, in his Treatise on Indigo, in 1776, upset all this, and attributed to cotton a power of elective attraction, by which all the phenomena of dyeing were referred to purely chemical principles. Macquer soon adopted the chemical theory, and it was keenly advanced by Berthollet, who succeeded Dufay, Hellot, and Macquer, in the administration of the arts connected with chemistry. Berthollet has been followed by all, so far as I know, who have since that time written on the subject, but nothing like evidence has ever been produced; and if we only consider that chemical attraction necessarily involves combination, atom to atom, and, consequently, disorganization of all vegetable structure; that cotton wool may be died without injury to its fibre, and that that fibre remains entire, when, by chemical means, its color has again been removed, we shall find that the union of cotton with its coloring must be accounted for otherwise than by chemical affinity. In particular processes, as we shall afterwards see, attraction is no doubt exerted; but it is an attraction connected with structure, and, therefore, more mechanical than chemical.

When we examine with a powerful microscope a fibre of cotton, dyed either with indigo, with oxide of iron, chromate of lead, or the common madder-red, the color appears to be spread so uniformly over the whole fibre that we cannot decide whether the walls of the tube are dyed throughout, or that the coloring matter only lines their internal surface. But the microscope shows that the collapse which occurs in raw and bleached cotton is very considerably diminished in the dyed.

The greater number of specimens of Turkey-red, which I have examined, show the same uniformity of color; but in others of them, little oblong balls appear all along the inside of the tube, of the fine

pink shade of that dye, while the tube itself is colorless. It is in stout cloth dyed in the piece that these rounded masses occur, and the observation has been confirmed by several of my friends who are practiced in microscopic research. But I shall resume these observations with a more perfect instrument, which I hope soon to possess.

We have moreover the powerful analogy of the arrangement of coloring matter in plants, in support of this view of the case. "Cellular tissue," says Dr. Lindley, in his Introduction to Botony, "generally consists of little bladders, or vesicles, of various figures adhering together in masses. It is transparent, and, in most cases, colorless; when it appears otherwise its color is caused by matter contained within it." . . . . "The bladders of cellular tissue are destitute of all perforations, so far as we can see, although, as they have the power of filtering liquids with rapidity, it is certain that they must abound in invisible pores." . . . . "The brilliant colors of vegetable matters, the white, blue, yellow, scarlet, and other hues of the corolla, and the green of the bark and leaves, is not owing to any difference in the color of the cells, but to the coloring matter of different kinds which they contain. In the stem of the garden balsam, a single cell is frequently red in the midst of others which are colorless. Examine the red bladder, and you will find it filled with a coloring matter of which the rest are destitute. The bright satiny appearance of many richly colored flowers depends upon the colorless quality of the tissue. Thus in *Thysanotus fasciculatis*, the flowers of which are of a deep brilliant violet, with a remarkably satiny lustre, that appearance will be found to arise from each particular cell containing a single drop of coloring fluid, which gleams through the white shining membrane of the tissue, and produces the flickering lustre that is perceived." Cotton is itself cellular tissue, and the ligneous basis of all the forms of these vessels has the same chemical constitution.

I have alluded to another class of processes in dyeing in which the action much more resembles chemical affinity. I mean that in which pure cotton, by mere immersion in different liquids, withdraws a variety of substances from their solution. The "indigo vat" is a transparent solution, of a brownish yellow color, consisting of deoxidized indigo combined with lime, and containing seldom more than $\frac{1}{500}$th of its weight of coloring matter. By merely dipping cotton in this liquid, the indigo attaches itself to it in the yellow state, in quantity proportioned within certain limits to the length of the immersion, and all that is then necessary to render it blue is to expose it to the air. Here an inactive spongy substance exercises a power which overcomes chemical affinity, but the mixture, which is formed of cotton and indigo, possesses none of the characters of a chemical compound. We can only recognize, in this action, the same force, whatever that may be, which enables animal charcoal to decolorate similar liquids. Charcoal, as we have also seen, withdraws metallic oxides from their solution in alkalies. Cotton wool has the same power, and it is extensively used as a means of dyeing with the yellow and red chromates of lead. If lime in excess be added to sugar of lead, dissolved in a considerable quantity of water, the lead which

precipitates is redissolved in the lime water, and forms a weak solution of plumbate of lime. If a piece of cotton be immersed in this solution it appropriates the lead, and when afterwards washed, and dipped in a solution of chrome, the lead becomes chromate of lead.

The same force enables cotton to imbibe basic salts of iron and tin by immersion in certain solutions of these metals; and many other examples of what Berzelius calls a cytalytic force, in decomposing weak combinations, will occur to those who are familiar with the art of dyeing.

It appeared to me interesting to compare the amount of surface exposed by cotton wool, with that of the more minute divisions of charcoal. I am enabled to furnish the following calculation through the kindness of Professor Balfour, who has measured with great care the fibres of various qualities of wool. The fibre of New Orleans wool varies most commonly from $\frac{1}{1500}$th to $\frac{2}{2000}$th of an inch in diameter. About forty of these fibres, or tubes, compose a thread of No. 38 yarn, (thirty-eight hanks to the pound.) Ordinary printing cloth, has, in the bleached state, 493 lineal feet of fibre, or 10.6 square inches of external surface of fibre in a square inch, which weighs nearly one grain. It is easy to compress 210 folds of this cloth into the thickness of one inch. It has then a specific gravity of 0.8. One cubic inch has 94.163 lineal feet of tube, and 16.8 feet of external surface; or, if we include the internal surface, there are upwards of 30 square feet of surface of fibre in one cubic inch of compressed calico. The charcoal of box-wood, has, as we have seen, 73 square feet of surface to the inch, with a specific gravity of 0.6.*

Lond., Edin. & Dub. Phil. Mag.

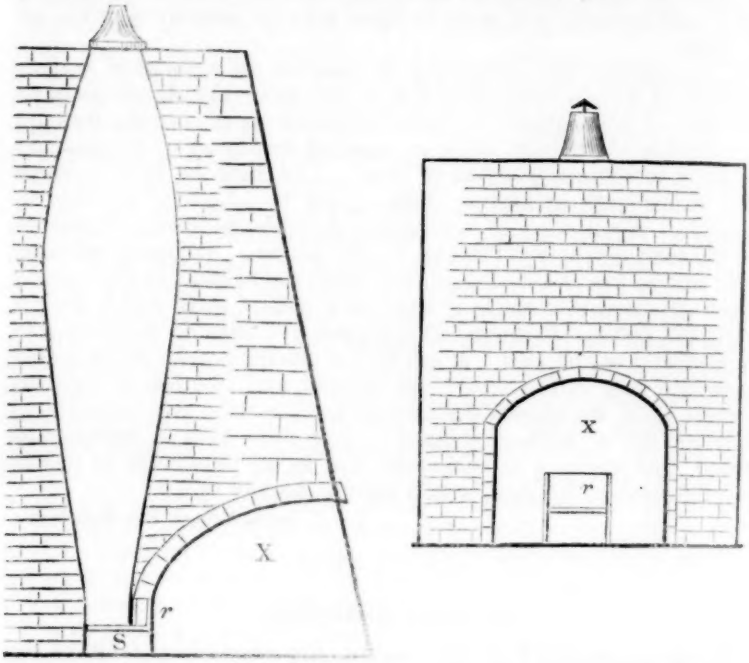
Improved Lime-Kiln.

Having represented to Mr. Duffus, the scientific curator of the Royal Dublin Society's Agricultural Museum, that we had received very many inquiries respecting an improved lime-kiln, and requested his assistance to enable us to present the plan of one to our readers, he has kindly complied with our request, by sending us a sketch, from which the accompanying wood cut was prepared, together with the following description:—

Sir,—The lime kiln, of which I have sent you a sketch, is one of the best and cheapest of those in use at Closeburn. The interior is circular, and the outline, as seen in the sectional elevation, resembles that of the body of a salmon: the diameter at the fuel-chamber is 3 feet—at 20 feet from the grating the diameter is 7 feet, contracting again to 3 feet at the top; and the entire height of kiln is 36 feet, 2 feet of which are below the grating. There are double cast-iron doors for the fuel-chamber, placed at 9 inches, or a foot, asunder; the space between being filled with air, the escape of heat is effectually prevented. These doors are at *r*; they are 3 feet wide by 1½ foot

* For drawings of cotton and linen see Philos. Mag., Nov. 1834, (S. 3, vol. v, p. 355.)

high. One door of the same size is on the ash-chamber. The grating over the ash-chamber S, is constructed of hollow bars of iron; the hollow admits a current of air, and prevents the decay of the bars. The bars are two inches wide, 3 inches deep, and the metal ¼ inch thick. Through the door above the grating, the burnt shells are withdrawn; through the door below, the lime ashes are taken out.



Besides the air admitted through the ash-chamber, there are side openings for additional supplies of air, and by means of which the draught may be regulated. This is an important object to keep in view; if the draught be too strong, the lime-stone is apt to be vitrified. To save the expense of doors, the side openings may have stones fitted to them, to be put out, or in, at pleasure. X, is the covered area under which the lime lies to cool, and carts are loaded; it is 12 feet high, by 10 feet wide at the mouth.

The internal masonry of the kiln should consist of fire bricks; the masonry in front may be either brick, or stone.

The kiln, of which you have here a sketch, is built on the side of a bank, which is always the most convenient site when the nature of the place affords it. A bank beside a lime-kiln, is, in fact, a machine erected and worked without cost, inasmuch as it saves the inclined plane, or tackle, that would be necessary if the kiln was built in the midst of a plain.

The kiln is furnished at the top with Booker's conical cover; it

turns on a pivot in its periphery, and rests on a curb-ring fixed to the masonry. It is 3 feet in diameter at base, and 3 feet high, with an opening of 1 foot at the top. Over this opening Menteath places a lid for regulating the draught, or for keeping out rain; instead of which I would add to the conical cover a small iron *umbrella*, that might be screwed up, or down, at pleasure. This I have sketched in the front elevation. It is necessary to put on the lid of a rainy day, at a time, perhaps, when the greatest draught of air is required. The umbrella cover would have this advantage—it would admit of a great draught, and yet effectually exclude the rain.

A kiln of this construction possesses many important advantages. Some of these advantages will be readily seen by an inspection of the sketch. The double doors, by confining the air between them, economize the heat—an object, towards the attainment of which, the shape and proportion of the entire structure greatly contribute.

The cover keeps in the heat, and keeps out the rain. When the rain is freely allowed to fall on the kiln, it wastes the heat, and also the space, by slackening the lime.

As respects the useful effect, Mr. Menteath says, (*High. Soc. Trans.* vol. viii,)—"These narrow kilns admit of there being drawn out of them every day, if fully employed, more than two-thirds, or nearly three-fourths, of their contents of well burnt lime, and afford fully three of lime shells for one measure of coal, when large circular kilns will not give out more than one-half of their contents every day, and require nearly one of coal for every two measures of lime."

I have not attempted to give you an estimate of the expense, as that can easily be done by any builder in the locality where a kiln is intended, who must of course, know the expense of fire bricks, workmen's wages, &c., in that locality. Suffice it to say, that a kiln of this construction will be found one of those things that soon affords abundant remuneration for the original outlay. I remain, &c.,

February 12th, 1844. J. Duffus.

Lond. Farmer's Mag.

On the Chemical History of Sugar. By Mr. Fownes.

After a slight description of the properties and distinctive characters of the more important of the sweet principles of the vegetable kingdom, the lecturer proceeded to discuss the subject of the practical manufacture of raw and refined sugar from the juice of the cane. The sugar-cane itself, originally a native of India, or China, was introduced into Sicily, by the way of Egypt and Syria, at a period antecedent to the crusades. It was carried, in 1420, by the Portuguese to Madeira, and, subsequently, by the same people, and the Spaniards, to Brazil, and to the West India Islands. The process of sugar making in the British West India colonies, has probably undergone but little change for two centuries, or more, except in the improvement of the machinery for crushing the ripe canes, and extracting the juice. The tempering with lime, clarifying by heat, and quick evaporation

in a series of open pans, still remain. Under the most favorable circumstances, a large quantity of molasses is always produced; and, as we know from the experiments of M. Peligot, that nothing but crystalizable sugar exists in the juice of the cane, this production of treacle must be ascribed to an alteration of the sugar from the high temperature of the liquid in the open pans towards the termination of the boiling. The excellent plan now adopted by the refiners of the raw, or Muscovado, sugar, for concentrating their purified and bleached sirop, by evaporation, in vessels from which the air is exhausted, patented in 1813, by the Hon. C. E. Howard, was then described and illustrated, and its adoption in the sugar islands, for concentrating to the necessary degree the clarified cane juice, strongly recommended. Under this system the product of sugar would be greatly increased, and its quality much improved, while little uncrystalizable sirop would be produced. This is, however, but a part, although an essential one, of the improvement of which the sugar cultivation and manufacture are susceptible. The East India sugars are made in part from the juice of a palm; the crude product, or *jaggery*, is subjected to a kind of refining process before exportation. These sugars are softer and less crystaline, and inferior in sweetness to those of the West Indies. The cause of the latter fact is to be sought for in the quantity of *grape sugar* they contain, which, indeed, is found more, or less, in every sample of raw sugar, having been produced in the first boiling at the expense of the crystalizable portion. For the purpose of detecting the presence of the grape sugar, recourse may be had to a beautiful experiment of Trommer, described in the "Annalen der Chemie und Pharmacie," for 1841, p. 360. The sugar to be examined is dissolved in water, mixed with a solution of sulphate of copper, and then a large excess of caustic potash added. The blue precipitate at first thrown down is redissolved with intense purplish-blue color by the excess of alkali. So far, both cane and grape sugar behave alike; but on heating the liquid to the boiling point, the cane sugar solution undergoes but little change, while that containing the grape sugar yields a copious precipitate of brilliant red sub-oxide of copper. It was suggested that this experiment might possibly be put into a form applicable to the *assay* of sugars, in which the proportion of grape sugar—that is, worthless sugar—should be inferred from the quantity of sub-oxide of copper produced from a given weight of the sample. The cheaper kinds of raw sugar, chiefly consumed by the poor, are sometimes cruelly adulterated by an intentional admixture of grape sugar, manufactured on a large scale for the purpose from potato-starch. This is a fraud which should be suppressed.

Civ. Eng. & Arch. Journ.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

On Compensating Pendulums.

At the meeting of the Société Philomathique, held July 29th, 1843, M. Vincent, in behalf of M. Egger, Professor of Greek Literature in

the Faculty of Arts, communicated a method of constructing compensating pendulums, in which the two metals employed are connected by joints, and which have, in consequence, the advantage of being entirely free from all want of homogeneousness, arising from soldering. This method is founded upon the following principle:—Let a, be the hypotenuse of a right angled triangle, and b, one of the sides adjacent to the right angle. If these two lines are represented materially by metallic rods of different kinds, the third side h, will retain a constant length, provided the lengths of a and b, and their respective coefficients δ, and δ^1, satisfy the following conditions:—

$$a^2 - b^2 = a^2(1+\delta)^2 - b^2(1+\delta^1)^2,$$

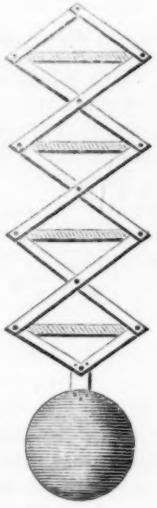
whence, in neglecting the very small fractions of the second order,

$$a^2\delta - b^2\delta^1 = 0, \text{ or } a : b :: \sqrt{\delta^1} : \sqrt{\delta}.$$

If, for example, the hypotenuse a, is of iron, and the side b, of brass, we shall have $\delta^1 : \delta :: 19 : 12$, very nearly, whence

$$a : b :: \sqrt{19} : \sqrt{12} :: 5 : 4, \text{ very nearly.}$$

Thus we shall obtain a sufficiently perfect compensation by a hypotenuse of iron = 5, and one side of brass = 4, whence it follows that the other side will be represented by 3, which we will assume as the height.



Nothing is more easy to construct than this figure; it is the celebrated triangle with which Pythagoras discovered the proposition of the square of the hypotenuse.

To apply it, suppose we place together four triangles, so as to form a lozenge, of which the sides are iron, and = 5, while one diagonal of brass = 8: the second diagonal, (the matter of which is of no importance,) will = 6, whatever may be the temperature. Now let us imagine a series of these lozenges arranged together firmly, one above the other in the same vertical plane; and to this effect, suppose iron bars the length of each = 5, first united two by two, in the form of a cross, and joined by their middles, then let the different couples be united and joined together by their ends, so that all the centres shall be in the same vertical line; and let the adjoining couples be separated from each other by horizontal brass bars each = 4. The total height of this system will remain constant, and equal to 3, multiplied by the number of lozenges: this height will be the length of the pendulum. —*L'Institut.*

Jeffery's Patent Marine Glue.

In the course of a series of experiments which Mr. Jeffery tried with various substances, he succeeded in discovering the composition

to which he has given the name of "marine glue," the peculiar properties of which are its being insoluble in, and impervious to, water; elastic, so as to expand, or contract, according to the strain on the timber, or the changes of temperature; sufficiently solid to fill up the joints, and add strength to the timber construction; and adhesive, so as to connect the timbers firmly together.

To make the marine glue:—A solution is first made of caoutchouc of good quality with coal naphtha, in the proportion of one pound of the caoutchouc to five gallons of the naphtha. The caoutchouc is cut into thin shreds before being used; and the mixture is stirred until the caoutchouc is so dissolved as to bring it to the consistence of thick cream. Mr. Jeffery finds that the caoutchouc is sufficiently dissolved in about ten, or twelve, days.

One part by weight of the above described solution, and two parts by weight of shellac, are then put into an iron vessel. The whole is then heated and stirred until thoroughly amalgamated: and this substance constitutes the marine glue. Edin. New Philos. Mag.

Detonation of the Alloy of Potassium and Antimony.

This alloy, as is well known, may be prepared by calcining the potassio-tartrate of antimony. MM. Fordos and Gélis state, however, that when the mass has not been sufficiently heated, and the metallic alloy has not separated, a porous mass is obtained composed of the alloy and charcoal, which detonates without being moistened, and by the mere blow by which it is attempted to be separated from the crucible; the above named chemists state that one of them was wounded by the explosion which occurred with a mass of this alloy. *Journ. de Ph. et de Ch., Octobre*, 1843.

Lond., Edin., and Dub. Philos. Mag.

A New Constant Battery.

M. le Prince Pierre Bagration has invented a new and simple constant galvanic battery, the particulars of which have been communicated by M. Jacobi, to the Academy of Sciences, at St. Petersburgh. Its elements are zinc, copper, and sal ammoniac; common earth saturated with the latter acting as a porous diaphragm. A plate of copper, and a plate of zinc, placed at a distance, the one from the other, in a flower-pot, or any other water-tight vessel, filled with earth saturated with a concentrated solution of sal ammoniac, form a voltaic pair, whose action will, after a short time, continue constant, and be maintained for whole months, and, to every appearance, for years; the only care necessary being from time to time to remoisten the earth, and renew the zinc. Before putting the copper plate into the earth, it should be plunged for some minutes in a solution of sal ammoniac, and then left to dry, until it receives a greenish coating. This operation renders the effect of the battery much more prompt;

and in regard to it, brass may be preferable to copper. The plates should not be too near each other, nor too small, because the earth opposes great resistance to the current. This form of battery is susceptible of many applications, but it will chiefly be useful where a constant and prolonged action, rather than energetic effect, is required; as, for example, in the reduction of metals, chemical decomposition, &c. It may be extended, however, to any quantity, or intensity. Whenever a series of numerous elements is used, the vessels should be well insulated. M. Jacobi has had one of the sal ammoniac batteries of twenty-four elements in action for six weeks, without the necessity of making the least change in it.

English Patents.

Specification of a Patent granted to Frederick Steiner, *of the county of Lancaster, for a new manufacture of certain Coloring Matter, commonly called Garancine.—Sealed August* 8, 1843.

My invention consists in manufacturing a certain coloring matter called garancine, from refuse madder, or madder which has been previously used in dyeing; such madder having, prior to the said invention, ordinarily been thrown away as spent, and of no value; and the said coloring matter called garancine, having been produced heretofore from fresh, or unused, madder. And I do further declare in what manner the said invention is to be performed as follows:—Outside the building in which the dye vessels are situate, I construct a large filter, formed by sinking a hole in the ground, and lining it at the bottom and sides with bricks, without any mortar to unite them. Upon the bricks I place a quantity of stones, or gravel, and over the stones, or gravel, common wrappering, such as is used for sacks. Below the bricks is a drain to take off the water which passes through the filter. In a tub adjoining the filter is kept a quantity of dilute sulphuric acid, of about the specific gravity of 105, water being 100. Hydro-chloric acid will answer the several purposes for which I use sulphuric acid, though I prefer sulphuric acid as more economical. A channel is made from the dye vessels to the filter. The madder which has been employed in dyeing, and which is in the state considered as spent, or refuse, madder, is run from the dye vessels to the filter, and while it is so running, such a portion of the dilute sulphuric acid is run in, and mixed with it, as changes the color of the solution, and the undissolved madder, to an orange tint, or hue. This acid precipitates the coloring matter which is held in solution, and prevents the undissolved madder from fermenting, or otherwise decomposing. When the water has drained from the madder through the filter, the residuum is taken from off the filter, and put into bags. The bags are then placed in a hydraulic press, to have as much water as possible expressed from their contents. After the press has been applied to the bags, I generally find about one-half, or two-thirds, of their

contents to consist of water. In order to break the lumps which have been formed by compression, the madder, or residuum, is passed through a sieve. To five cwt. of madder in this state, placed in a wood, or lead, cistern, I add one cwt. of sulphuric acid of commerce, by sprinkling it on the madder through a lead vessel, similar in form to the ordinary watering can used by gardeners. I next use an instrument like the garden spade, or rake, to work the madder about, so as to mix it intimately with the acid. In this stage I take the madder and place it upon a perforated lead plate, which is fixed about five, or six, inches above the bottom of a vessel. Between this plate and the bottom of the vessel; I introduce a current of steam by a pipe, so that it passes through the perforated plate, and the madder which is upon it. During this process, which occupies from one to two hours, a substance is produced of a dark brown color approaching to a black. This substance is garancine, and insoluble carbonized matter. I next throw this substance on the floor to cool. When cool, I place it upon a filter, and wash it with clear, cold water, until the water passes from it without an acid taste. I then put it into bags, and press it with a hydraulic press. I next dry the substance in a stove, and grind it to a fine powder, under ordinary madder stones, and afterwards pass it through a sieve. In order to neutralize any acid that may remain, I add for every cwt. of this substance from four to five pounds of carbonate of soda in a dry state, and intimately mix them. The garancine in this state is ready for use.

Having now described the nature of the said invention, and the manner in which the same may be performed, I hereby declare, that I do not claim as of the said invention, or the exclusive use of the said several processes and operations herein before mentioned, except when the same are employed for the manufacture of garancine from spent, or refuse, madder. But I claim as my invention the manufacture herein before described of the coloring matter called garancine, from madder which has been previously used in dyeing, and which is usually called spent madder. And such invention being, to the best of my knowledge and belief, entirely new, and never before used within that part of her said majesty's United Kingdom of Great Britain and Ireland, called England, her dominion of Wales, and town of Berwick-upon-Tweed, and I do hereby declare this to be my specification of the same, and that I do verily believe this, my said specification, doth comply, in all respects, fully, and without reserve, or disguise, with the proviso in the said herein before in part recited letters patent contained; wherefore, I do hereby claim to maintain exclusive right and privilege to the said invention.—[Enrolled February 8, 1844.

Reper. Arts and Pat. Inven.

Specification of a Patent granted to WILLIAM DANIEL, *of the county of Monmouth, for improvements in Rolling Iron into Plates, or Sheets.—Sealed July* 22, 1843.

My invention relates to improvements in the manufacture of thin

plates, or sheets, of iron suitable for making tinned plate, and for other uses; and in order that my invention may be fully understood, and readily carried into effect, I will proceed to explain the means pursued by me.

In the manufacture of thin sheets of iron suitable for the making of tinned plate, and for uses where similar thin sheets of iron are required, it was formerly usual, and is still commonly the case, to subject the iron to repeated processes of piling and re-heating, by which, not only was much fuel employed, but the iron was much wasted; and in the repeated rollings, the rolling after each piling and re-heating was in the same direction, and the iron was rolled into bars about half an inch thick, and about six inches wide; the bars thus obtained were cut into lengths at the tin plate mill, and subjected to rolling between hard rollers, in the reverse direction to that in which they had before been rolled. Now, according to my invention, I avoid the repeated processes of piling, heating, hammering, and rolling of the iron, before reversing the direction of the rolling, and I obtain, not only a considerable saving of fuel, but, by avoiding the repeated piling and heating processes, heretofore considered necessary before reversing the direction of the rolling, I save the consequent cost of those, and of the successive processes of hammering and rolling after re-piling and reheating, and, at the same time, I produce superior thin sheets, or plates, of iron. In carrying out my invention, I take a ball of iron from a charcoal refinery, or from a puddling furnace, and submit it to the hammer, and then roll it into a bloom of about six inches wide, and five inches thick; I cause this bloom to be cut by a saw, or other convenient means, into lengths of from four to six inches, or other convenient length. These pieces are then to be immediately rolled, the grain of the pieces, when passing through between the rollers, being kept vertical, by which the upper and under surfaces of the bars produced therefrom will be the clean cut surfaces; and I roll each of these pieces till they are successively brought into bars about five inches wide, and two and a half inches thick, and with proper care no re-heating is required up to this process. And I would here remark, that although this process is necessary to the obtaining the upper and under surfaces according to my invention, I do not claim, generally, the rolling of iron into thin sheets, after cutting of blooms, and causing the pieces thereof to be rolled with the grain vertical, that mode of obtaining good surfaces having formed the subject of claim to invention under letters patent granted to me, bearing date at Westminster, the 16th day of April, 3 Geo. IV., in the year of our Lord 1822; but when making thin sheets, or plates, of iron, according to that invention, I caused the bars obtained to be repeatedly cut up and piled, re-heated, hammered, and rolled, retaining the cut surfaces above and below to the end of the process, continuing the rolling after each piling in the same direction as before, and the iron was brought into a bar of about half an inch thick, and six inches wide, which, being taken to the tin plate mill, was cut into lengths, and rolled into thin plates, or sheets, reversing the direction of rolling. Now, according to my present improvements, I avoid all those pro-

cesses of piling, hammering, re-heating, and rolling, before reversing the direction of rolling. I commence at once to roll in the transverse, or opposite, direction, on pieces of iron which have been produced from the cut bloom, as herein described; therefore, the bars of iron obtained by rolling the grain when vertical, after cutting, as above explained, in place of being repeatedly cut up, piled, heated, hammered, and rolled, in the same direction, are, according to my present invention, to be finished into thin plates, or sheets, by rolling the pieces thereof in the reverse direction to that in which the bars were rolled; and for this purpose I cut the bars into lengths according to the sizes of the plates to be made therefrom, and these pieces I cause to be heated in a suitable furnace, and I cause them to be rolled in grooved rollers, the width of the grooves being the same as the length of the pieces of iron, and the pieces of iron are to be rolled and lengthened out in a direction at right angles to the previous rolling, and I continue such rolling in successive grooves till the iron is reduced to about one-eighth of an inch in thickness, the width remaining about the same as the length of the piece of iron was before commencing rolling it at right angles to the direction in which the piece had been previously rolled. A piece of iron thus treated will then be in the state of what is technically called "a moulding," which is to be completed in a tin plate mill, by being cut into suitable lengths, and heated to a low red heat, and passed between hard rollers, as is well understood, then doubled, and again heated to a low red heat, and again rolled by hard rollers, and again doubled, and heated again to a red heat, and rolled into "black plate," the rolling being in the way of the length of the sheet, or plate; that is, I continue to roll the iron in the same direction, between the hard rollers, as it was rolled before coming to the hard rollers.

I would remark that I prefer to use the best refinery iron for the purposes of my invention, at the same time, I do not confine myself thereto, as thin sheets, made according to my invention, from puddling iron, will be found superior to the plates made of the same iron by the modes heretofore resorted to, in addition to which, there will be a great saving in making such plates, or thin sheets, according to my invention.

Having thus described the nature of my invention, and the manner in which the same is to be performed, I would wish it to be understood, that I do not confine myself to the precise details, so long as the peculiar character of my invention be retained. But what I claim, is the mode of rolling iron into thin sheets, or plates, for the manufacture of tinned plates, and other uses, by causing pieces of iron to be rolled out into sheets, or plates, by rolling them at right angles to the direction in which they have been produced, when such pieces have been obtained by rolling cut-iron with the grain in a vertical direction, the upper and under surfaces being those which result from the cutting, as above described.—[Enrolled January 22, 1844.]

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